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INVESTIGATION OF THE FLOW FIELD BENEATH THE WING OF THE F-4C AIRCRAFT WITH VARIOUS EXTERNAL STORES AT MACH NUMBER 0.85

David W. Hill, Jr.

ARO, Inc.

June 1972

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**INVESTIGATION OF THE FLOW FIELD BENEATH THE
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FOREWORD

The work reported herein was sponsored by the Air Force Armament Laboratory (AFATL/DLGC/Maj W. A. Miller), Armament Development and Test Center, Air Force Systems Command (AFSC), under Program Element 62602F, Project 2567.

The test results presented were obtained by ARO, Inc. (a subsidiary of Sverdrup & Parcel and Associates, Inc.), contract operator of the Arnold Engineering Development Center (AEDC), AFSC, Arnold Air Force Station, Tennessee, under Contract F40600-72-C-0003. The test was conducted from February 24 through March 6, 1972, under ARO Project No. PC0236. The manuscript was submitted for publication on May 5, 1972.

This technical report has been reviewed and is approved.

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Lt Colonel, USAF
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Colonel, USAF
Acting Director of Test

ABSTRACT

Tests were conducted to measure the velocity vector components in the flow field beneath the wing of the F-4C aircraft at Mach number 0.85. A conical-tip pressure probe was used to measure the velocity vectors beneath the wing with configuration combinations of pylons, Triple Ejection Rack (TER), Multiple Ejection Rack (MER), M-117, MK-81, and MK-84 stores. Results of the test indicate that the severity of the upwash and sidewash flow increased with the addition of pylons, TER, MER, and stores. The M-117 stores on the TER and MER produced the most severe flow field distortions. Also, the longitudinal gradients of upwash and sidewash flow decreased with an increase in aircraft angle of attack.

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NOMENCLATURE

M_∞	Free-stream Mach number
V_L	Magnitude of the local velocity vector in the aircraft flow field
V_x	Magnitude of the component of the local velocity vector parallel to the X_p axis
V_{xy}	Magnitude of the projection of the local velocity vector in the $X_p - Y_p$ plane
V_{xz}	Magnitude of the projection of the local velocity vector in the $X_p - Z_p$ plane
α	Angle of attack of the flow-field probe and the aircraft model, deg, positive nose upward as seen by the pilot
α_{xy}	Angle between the projection of the local flow velocity vector in the $X_p - Y_p$ plane, and the X_p axis, deg
α_{xz}	Angle between the projection of the local flow velocity vector in the $X_p - Z_p$ plane and the X_p axis, deg

FLIGHT-AXIS-SYSTEM COORDINATES (See Fig. 13)

- X_F Parallel to the free-stream wind vector, positive in the upstream direction
- Y_F Perpendicular to the free-stream wind vector in the horizontal plane, positive to the right looking upstream
- Z_F Perpendicular to the X_F and Y_F axes, positive in the downward direction

PROBE-AXIS-SYSTEM COORDINATES (See Fig. 13)

- X_p Parallel to the probe longitudinal axis, positive in the upstream direction
- Y_p Perpendicular to the probe longitudinal axis in the horizontal plane, positive to the right looking upstream
- Z_p Perpendicular to the probe longitudinal axis in the vertical plane, positive downward

FUSELAGE-AXIS-SYSTEM COORDINATES (See Figs. 4, 12 and 13)

- MBL Model buttock line - measured from, and perpendicular to, the aircraft plane of symmetry, positive to the right looking upstream, in.
- MFS Model fuselage station - measured parallel to the aircraft longitudinal reference line from an arbitrary reference point near the nose of the aircraft, positive in the downstream direction, in.
- MWL Model water line - measured perpendicular to the aircraft longitudinal reference line and parallel to the aircraft plane of symmetry, positive in the upward direction, in.

SECTION I INTRODUCTION

A test was conducted in the Aerodynamic Wind Tunnel (4T), Propulsion Wind Tunnel Facility (PWT), to determine the effect on the adjacent flow field of adding pylons, triple ejection rack, multiple ejection rack, and various external stores to the wing of the F-4C aircraft. The M-117, MK-81, and MK-84 weapon stores were used on the inboard and outboard pylon locations.

The flow-field measurements were obtained with a 40-deg conical probe attached to the Captive Trajectory System (CTS), which positioned the probe at selected points in a three-dimensional space beneath the F-4C wing. Data were obtained primarily at Mach number 0.85 and at aircraft angles of attack of 0.30 and 3.30 deg with various wing loading configurations. A few data points were obtained at Mach number 1.3, as indicated in Table I (Appendix II), but are not included herein.

SECTION II APPARATUS

2.1 TEST FACILITY

The Aerodynamic Wind Tunnel (4T) is a closed-loop, continuous flow, variable density tunnel in which the Mach number can be varied from 0.1 to 1.3. At all Mach numbers, the stagnation pressure can be varied from 300 to 3700 psfa. The test section is 4 ft square and 12.5 ft long with perforated, variable porosity (0.5- to 10-percent open) walls. It is completely enclosed in a plenum chamber from which the air can be evacuated, allowing part of the tunnel airflow to be removed through the perforated walls of the test section.

Two separate and independent support systems were used to support the models. The parent-aircraft model was inverted in the test section and supported by an offset sting attached to the main pitch sector. The flow probe was supported by the captive trajectory support (CTS) which extends down from the tunnel top wall and provides store movement (six degrees of freedom) independent of the parent-aircraft model. An isometric drawing of a typical parent-flow probe installation is shown in Fig. 1 (Appendix I).

Also shown in Fig. 1 is a block diagram of the computer control loop used during flow-field testing. The analog system and the digital computer work as an integrated unit and, utilizing required input information, control the probe movement during a survey. Probe positioning is accomplished by use of six individual d-c electric motors. Maximum translational travel of the CTS is ± 15 in. from the tunnel centerline in the lateral and vertical directions and 36 in. in the axial direction. Maximum angular displacements are ± 45 deg in pitch and yaw and ± 360 deg in roll. A more complete description of the test facility can be found in the Test Facilities Handbook¹. A schematic showing the test section details and the location of the aircraft model and flow-field probe in the tunnel is shown in Fig. 2.

¹Test Facilities Handbook (Ninth Edition). "Propulsion Wind Tunnel Facility, Vol. 4." Arnold Engineering Development Center, July 1971.

2.2 TEST ARTICLES

The probe used to obtain the flow-field measurements was attached directly to the CTS and consisted of a single cone-cylinder with a 40-deg included tip angle. There were four equally spaced static pressure orifices on the surface of the cone and a total-pressure orifice at the apex of the cone. Details and dimensions of the probe are shown in Fig. 3.

The test articles were 0.05-scale models of the F-4C aircraft and the various stores. A sketch showing the basic dimensions of the F-4C model is shown in Fig. 4. Details and dimensions of the pylon, multiple ejection rack (MER), and triple ejection rack (TER) models are shown in Figs. 5, 6, and 7, respectively. The M-117, MK-81, and MK-84 store models are shown in Figs. 8, 9, and 10, respectively.

The F-4C aircraft has two pylon stations on each wing. The mounting surfaces of the inboard and outboard pylons are inclined at a 1.0 deg nose-down angle with respect to the aircraft waterline.

Figure 11 illustrates the orientation of the store suspension lugs on the MER and TER.

2.3 INSTRUMENTATION

Static and total pressures on the cone probe were measured using 5-psid transducers. Translational and angular positions of the probe were obtained from the CTS analog outputs. The aircraft-model angle of attack was set using the main-sting-support readout system.

SECTION III TEST DESCRIPTION

3.1 TEST CONDITIONS

All data were obtained at Mach number 0.85 or 1.30 and a tunnel dynamic pressure of 900 psf. Tunnel conditions were held constant while flow-field data were being recorded.

3.2 DATA ACQUISITION

The regions beneath the F-4C aircraft wing where flow-field data were obtained are shown in Fig. 12. The flow probe was traversed in the F-4C fuselage-axis system parallel to the model centerline, model buttock line, and model waterline. The axis systems defining the flow-field velocity vectors and probe displacements are shown in Fig. 13. During testing, tunnel conditions were established and the probe tip was positioned at a known coordinate point relative to the F-4C model. At this position, initial-point data were taken which oriented the computer program controlling the CTS movement in the F-4C fuselage coordinate system.

After the initial data point was recorded, the computer automatically positioned the CTS and the flow probe at desired positions in the region of interest for a given configuration.

3.3 PRECISION OF DATA

Estimated uncertainties in probe positioning resulting from the ability of the CTS and main pitch sector to set on a specified value are shown below.

<u>ΔX, in.</u>	<u>ΔY, in.</u>	<u>ΔZ, in.</u>	<u>Δa, deg</u>	
			<u>Probe</u>	<u>Aircraft</u>
± 0.05	± 0.05	± 0.05	± 0.15	± 0.10

Estimated uncertainties in the data for the flow-field tests are as follows:

<u>M_∞</u>	<u>ΔM_∞</u>	<u>Δa_{xz}</u>	<u>Δa_{xy}</u>
0.85	± 0.005	± 0.25	± 0.25

SECTION IV RESULTS AND DISCUSSION

4.1 GENERAL

The data presented herein consist of local upwash and sidewash angles obtained from flow-field pressure measurements made beneath the left and right wing for various wing-loading configurations. Figure 13 shows the angles with their respective velocity vectors. During testing, data were obtained to determine the effect of pylon, TER, MER, M-117, MK-81, and MK-84 models on the flow field beneath the wing of the F-4C aircraft at Mach numbers 0.85 and 1.30 and aircraft angles of attack of 0.30 and 3.30 deg. Because of the large volume of data obtained, only representative data are presented herein. Configurations, regions surveyed, and test conditions for the data obtained during the test may be seen in Table I. All data presented are for Mach number 0.85.

Velocity-vector flow angles are presented in terms of the upwash, a_{xz} , and sidewash, a_{xy} , as functions of position beneath the F-4c wing in Figs. 14 through 26. Positive values of a_{xz} indicate an upwash flow and positive values of a_{xy} indicate a sidewash flow outward on the right wing or inward on the left wing. For clarification, a side view sketch (drawn to scale) of each configuration is presented at the top of each figure.

4.2 INBOARD REGION FLOW-FIELD DATA

Figures 14 through 21 present the flow-field data for the inboard region surveyed at MBL locations of 3, 4, and 5 (or -3, -4, and -5). These data show that the most severe upwash and sidewash flow gradients occur with the TER fully loaded with M-117 stores.

The MK-84 store produced more severe gradients than the TER fully loaded with MK-81 stores. In general, the sidewash flow gradients are greater on either side of the pylon location (MBL 3 and 5) than they are directly below the pylon (MBL 4) for the TER fully loaded with M-117 and MK-81 stores.

For any configuration, the upwash and sidewash have decayed to near free-stream values at a MWL of -6. The magnitude of the upwash and sidewash angles increased with the addition of the pylon, TER, and stores. Abrupt changes in upwash and sidewash flow occur at the nose region of the stores.

4.3 OUTBOARD REGION FLOW-FIELD DATA

Figures 22 through 26 present the flow-field data for the outboard region surveyed at MBL 6, 7, and 8 (or -6, -7, and -8) locations.

The most severe upwash and sidewash gradients occur with the MER fully loaded with M-117 stores. The MK-84 produced greater upwash and sidewash gradients than the MER fully loaded with MK-81 stores. In general, increasing the aircraft angle of attack from 0.3 deg to 3.3 deg decreased the longitudinal gradients of the upwash and sidewash flow. For any configuration, upwash and sidewash flow have decayed to near free-stream values at a MWL of -6.

Abrupt changes in upwash and sidewash flow occur at the store nose regions of the forward and aft stores on the MER.

SECTION V CONCLUSIONS

Based on the results of this investigation to determine the effect of various wing-loading configurations on the flow field beneath the F-4C aircraft wing, the following conclusions were reached:

1. The magnitude of the upwash and sidewash flow angles and gradients increases with the addition of the pylon, TER or MER, and stores.
2. Abrupt changes in upwash and sidewash flow occur at the nose regions of the stores on the MER and TER.
3. The most severe upwash and sidewash flow gradients occur with the TER or MER fully loaded with M-117 stores.
4. In general, the sidewash flow gradients are greater on either side of the pylon location (MBL 3 and 5 for TER and MBL 6 and 8 for MER) than directly below the pylon (MBL 4 and 7).

5. For any configuration, the upwash and sidewash flow gradients decay significantly at MWL-6.
6. In general, increasing the aircraft angle of attack from 0.3 to 3.30 decreases the longitudinal gradients of upwash and sidewash flow.

APPENDIXES
I. ILLUSTRATIONS
II. TABLE

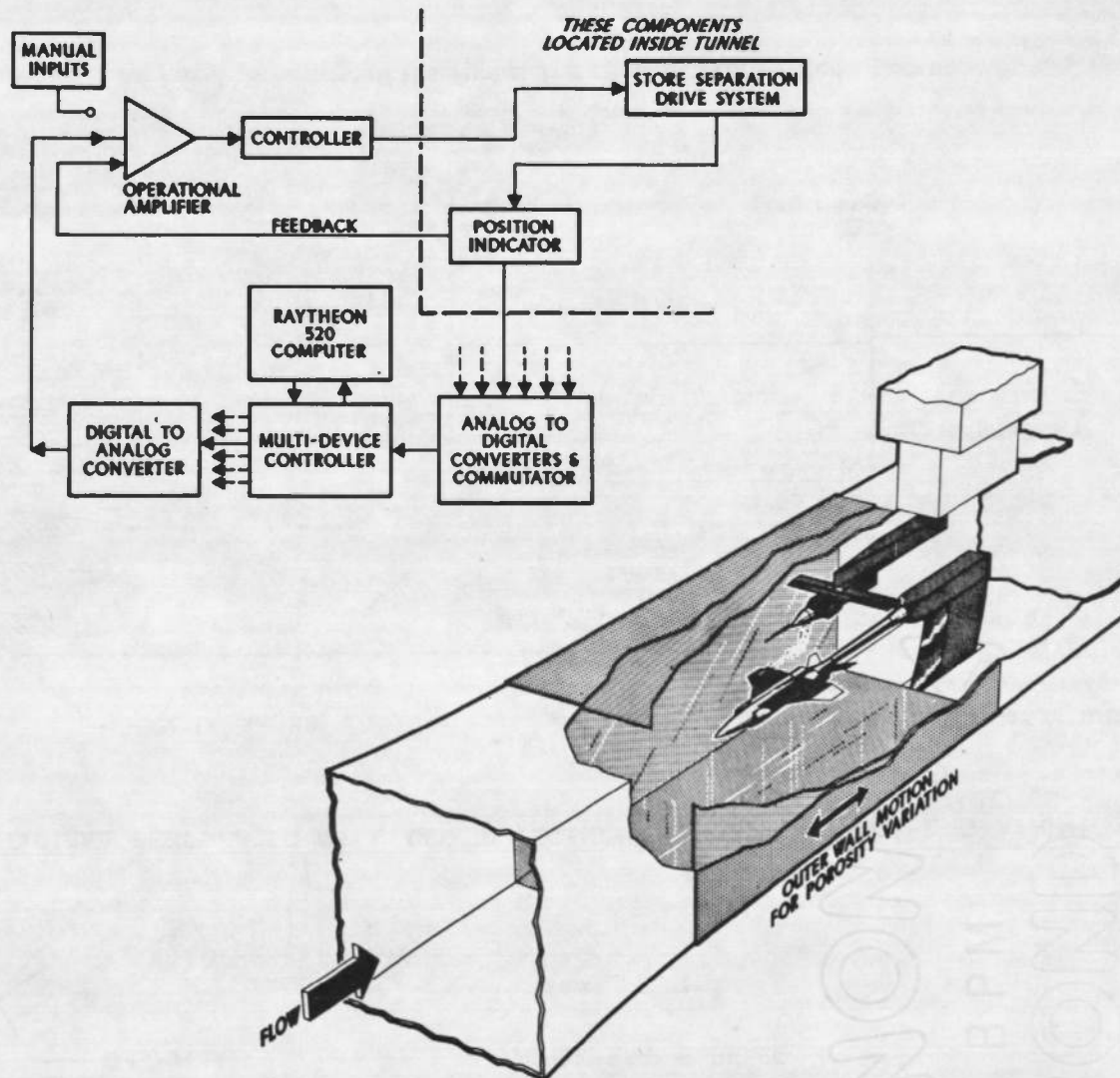


Fig. 1 Isometric Drawing of a Typical Flow-Field Probe Installation and a Block Diagram of a Computer Control Loop

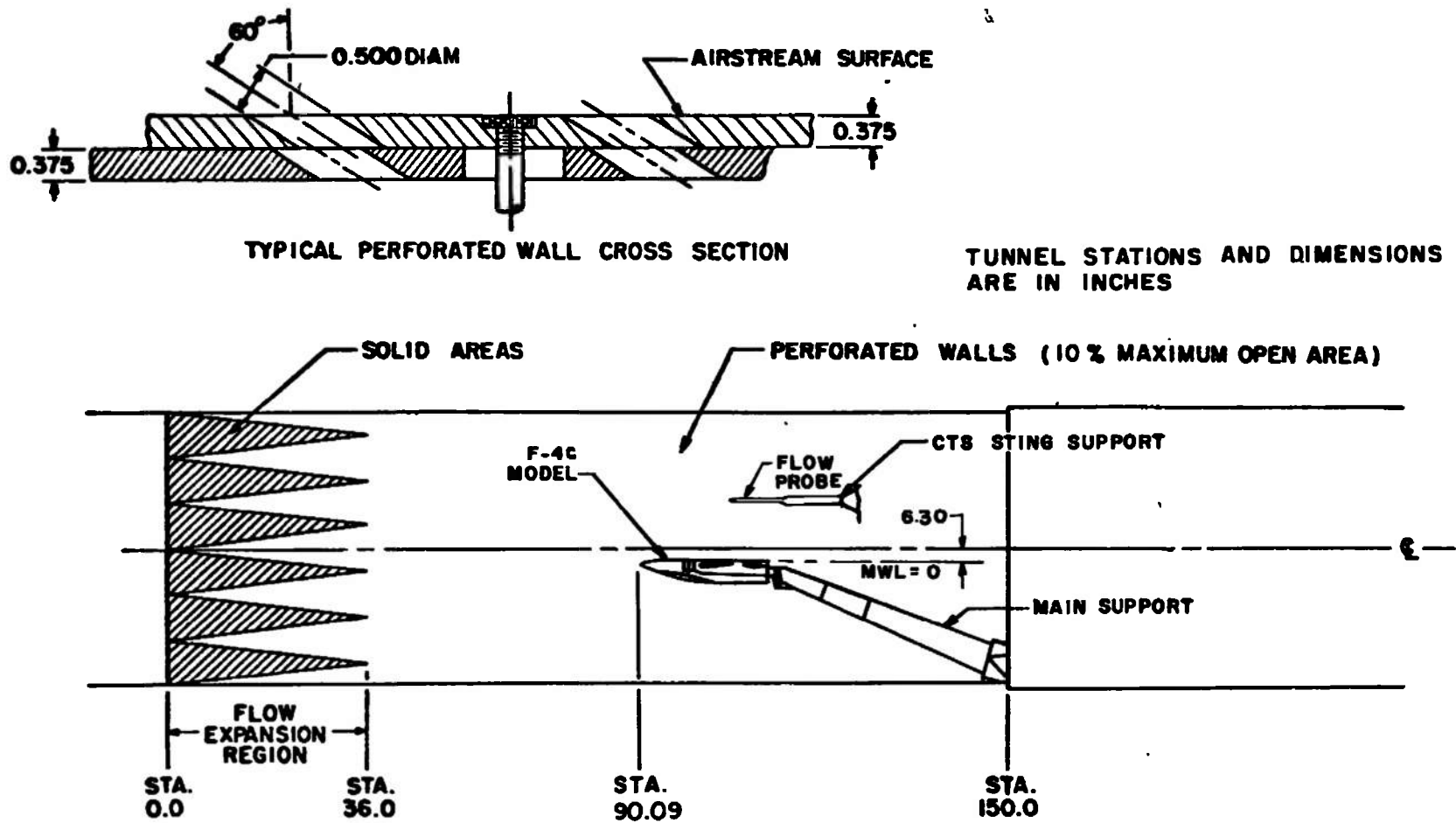
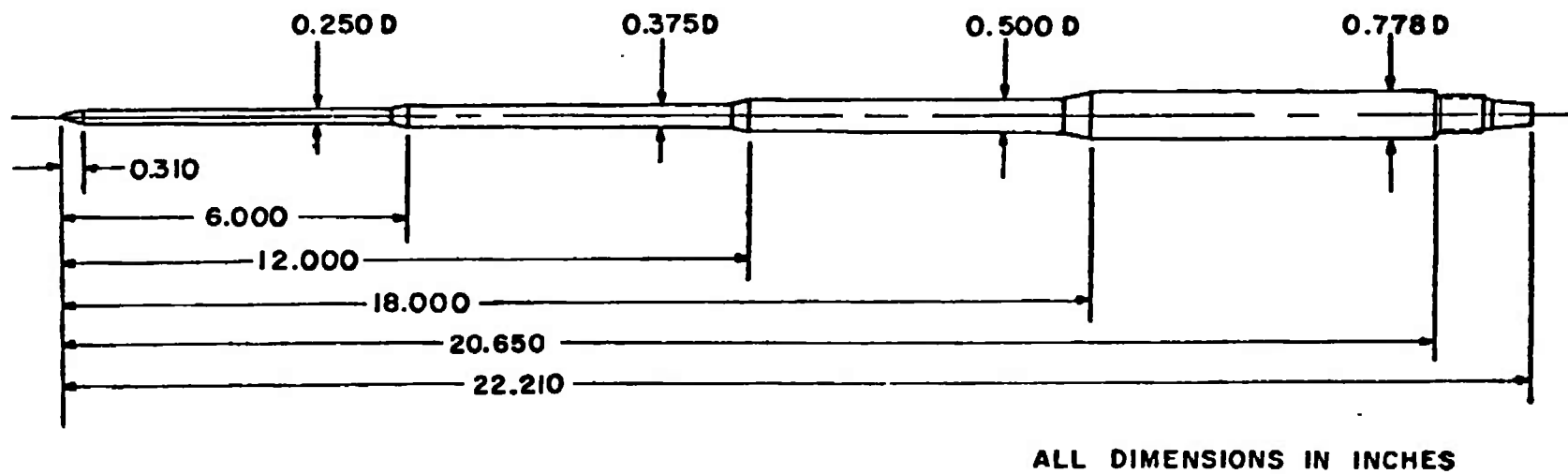
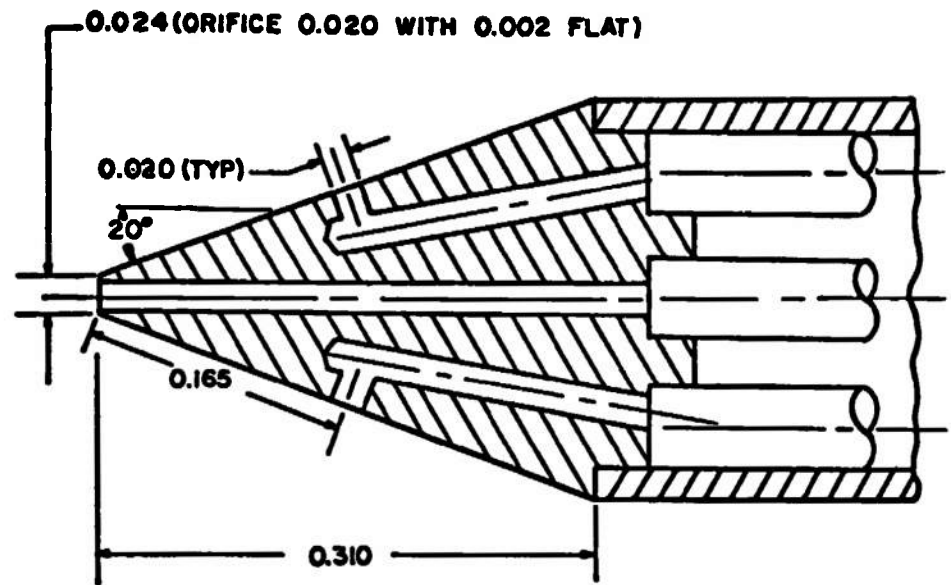
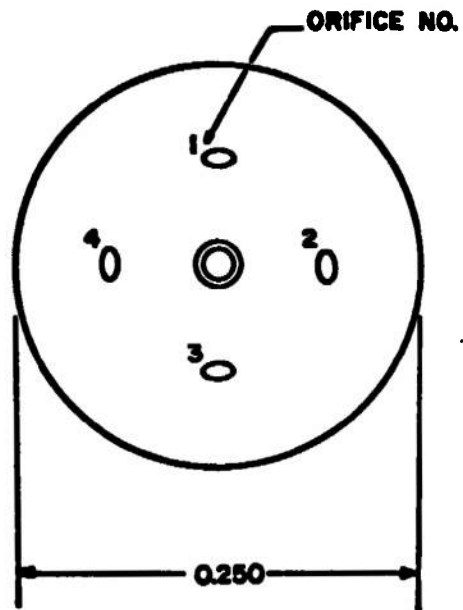


Fig. 2 Schematic of the Tunnel Test Section Showing Model Location



a. General Details
Fig. 3 Details and Dimensions of the 40-deg Cone Probe



ALL DIMENSIONS IN INCHES

b. Probe Tip Detail
Fig. 3 Concluded

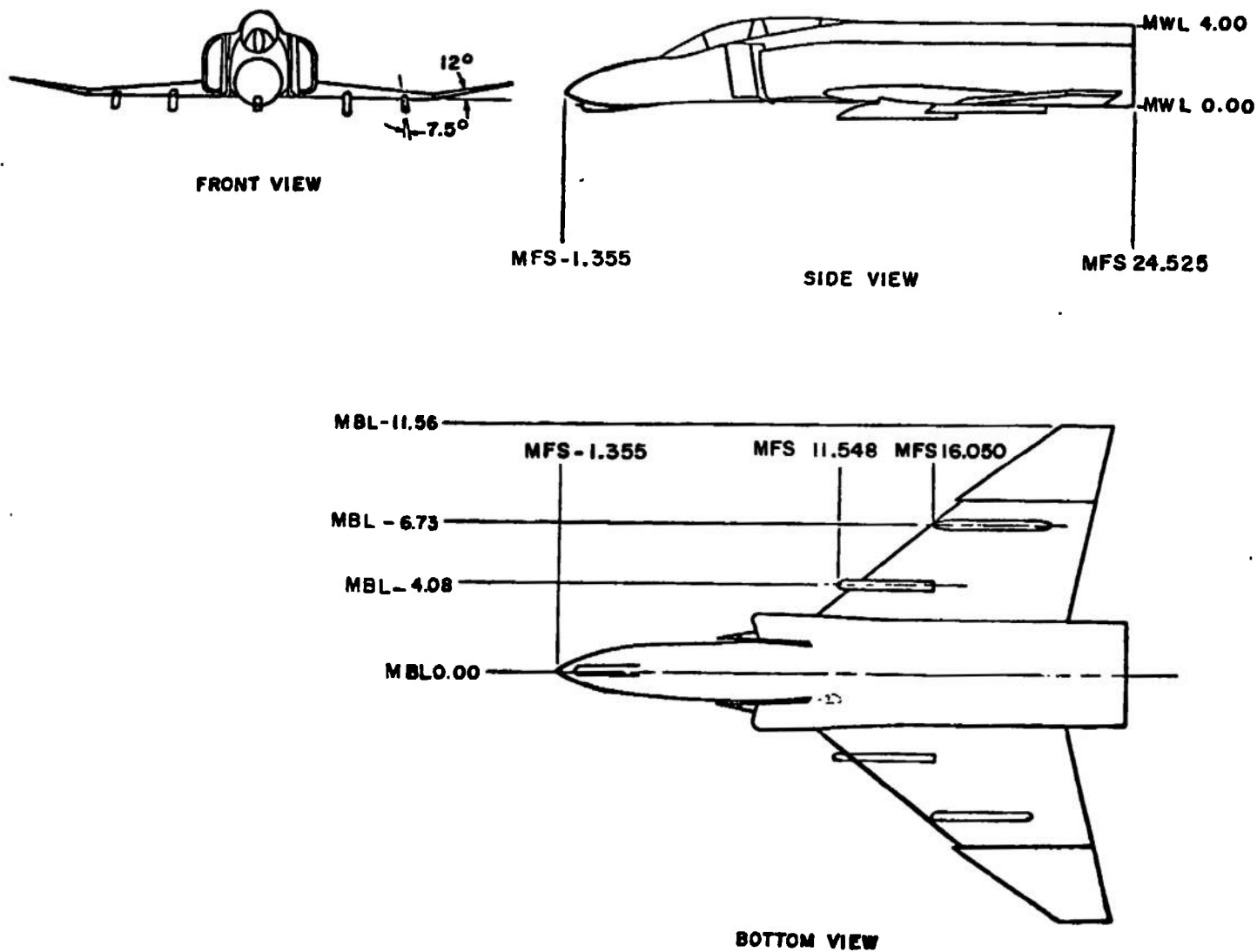
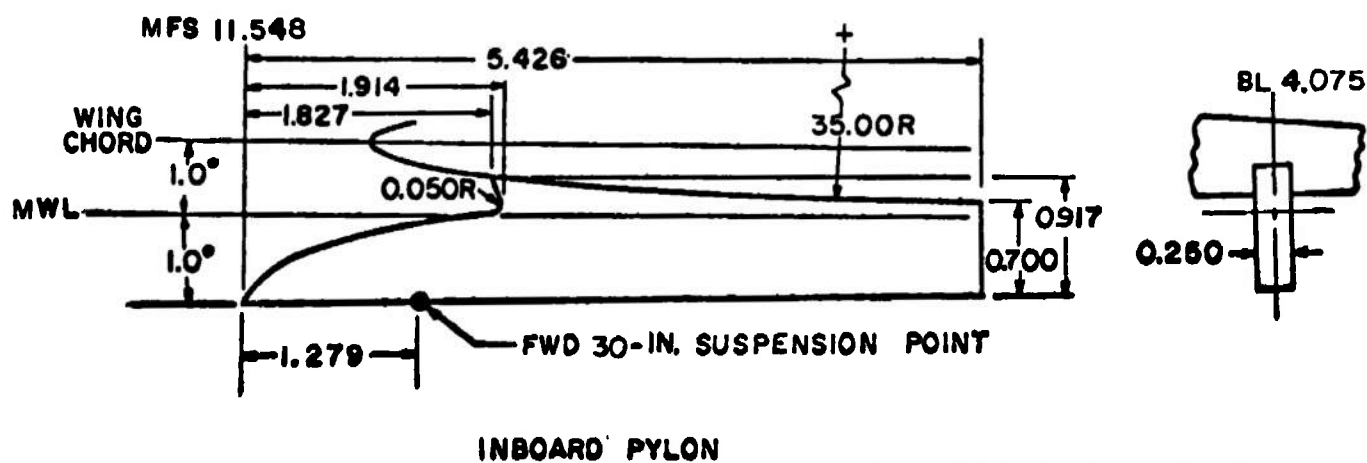
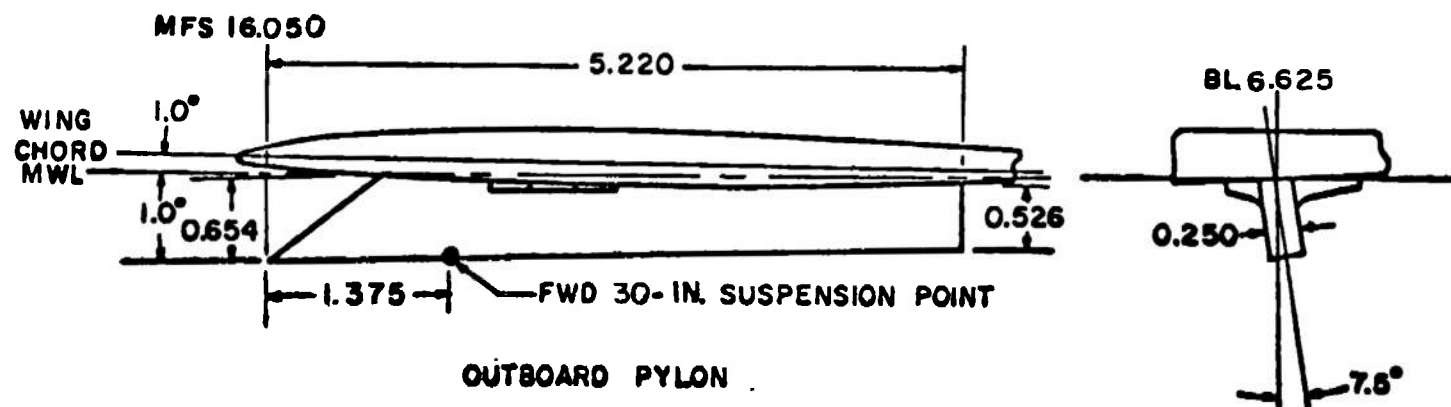


Fig. 4 Sketch of the F-4C Parent-Aircraft Model Showing Pylon Locations



ALL DIMENSIONS AND MODEL
STATIONS IN INCHES

Fig. 5 Details and Dimensions of the F-4C Pylon Models

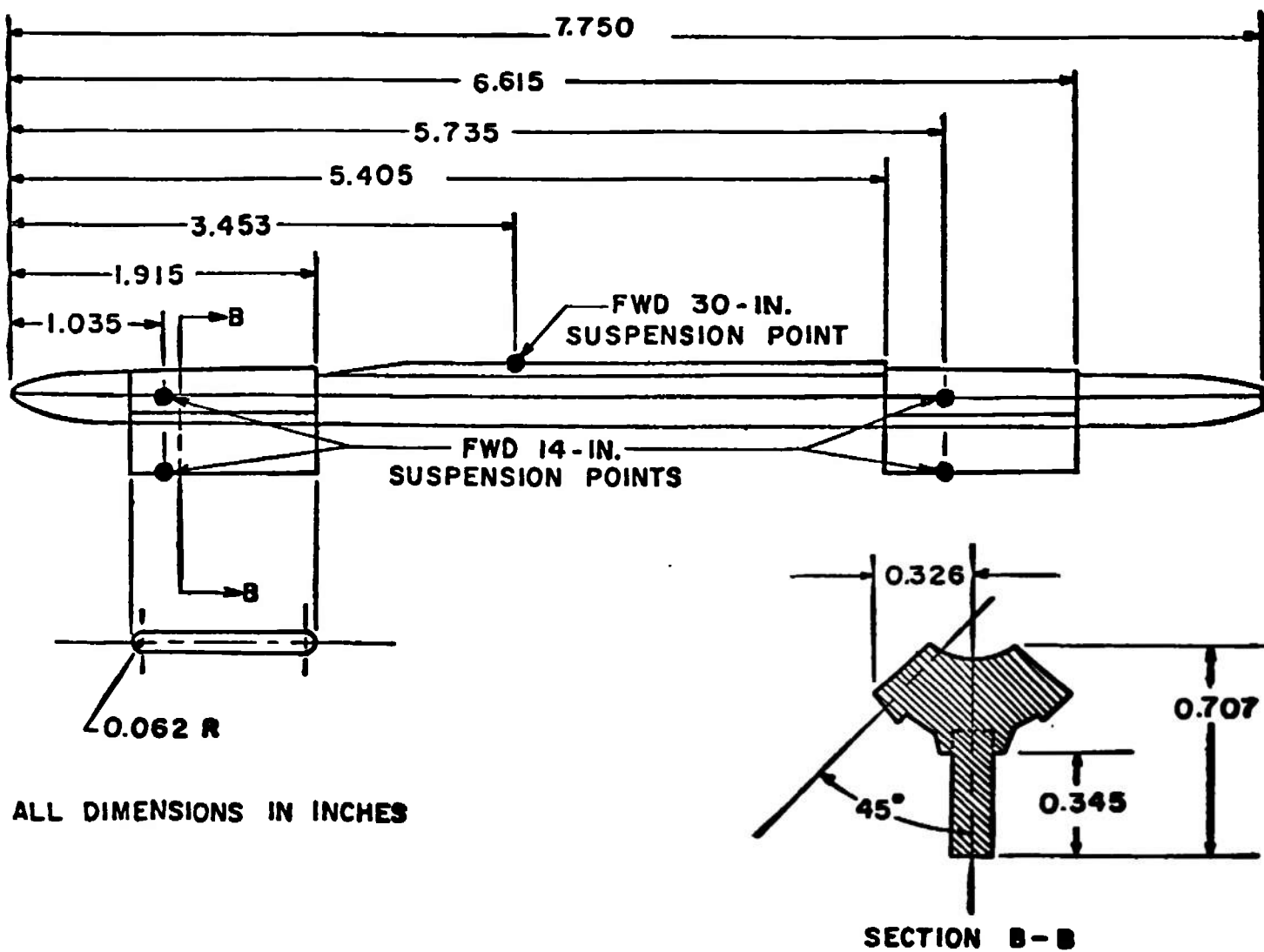


Fig. 6 Details and Dimensions of the MER Model

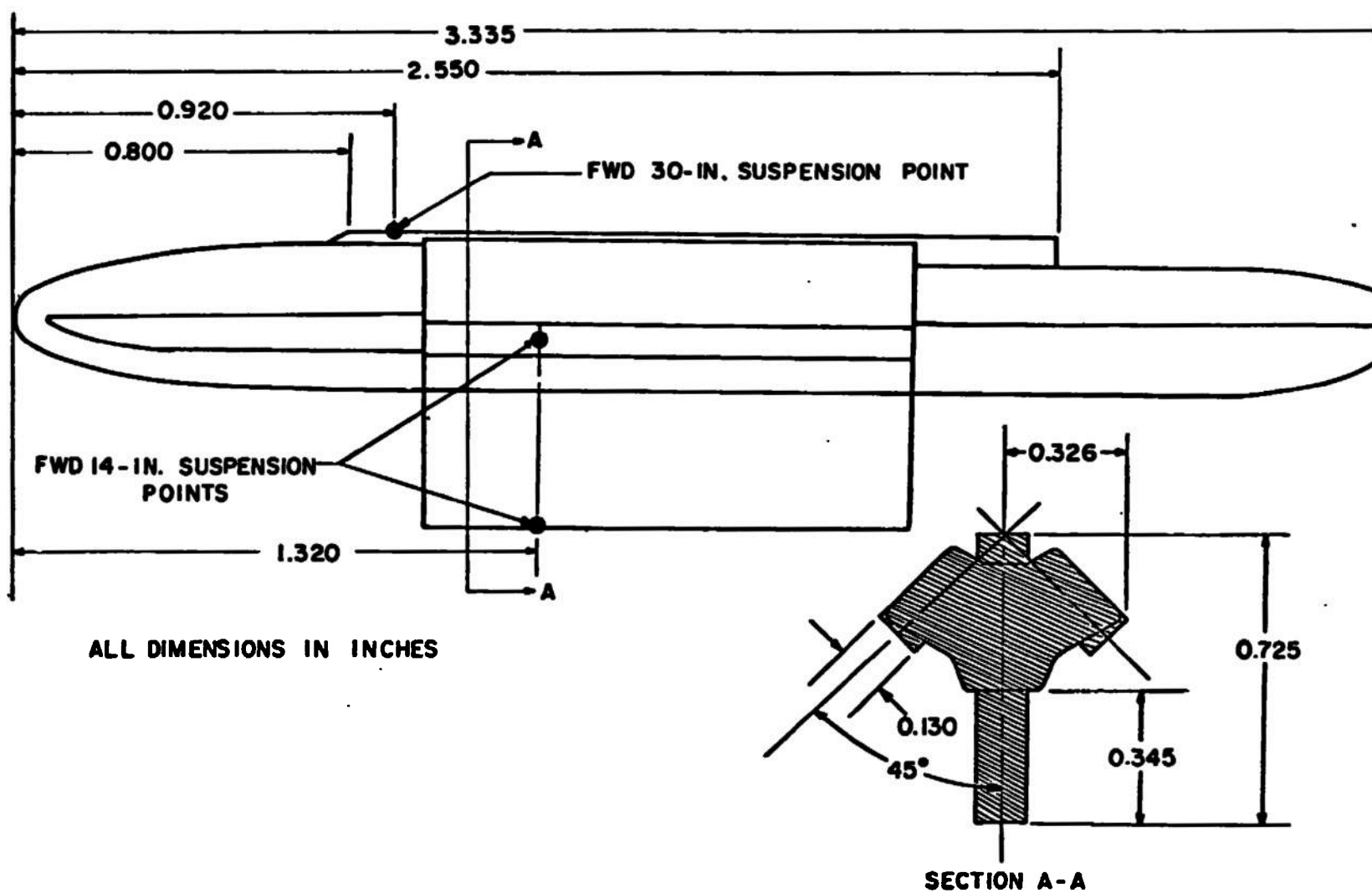


Fig. 7 Details and Dimensions of the TER Model

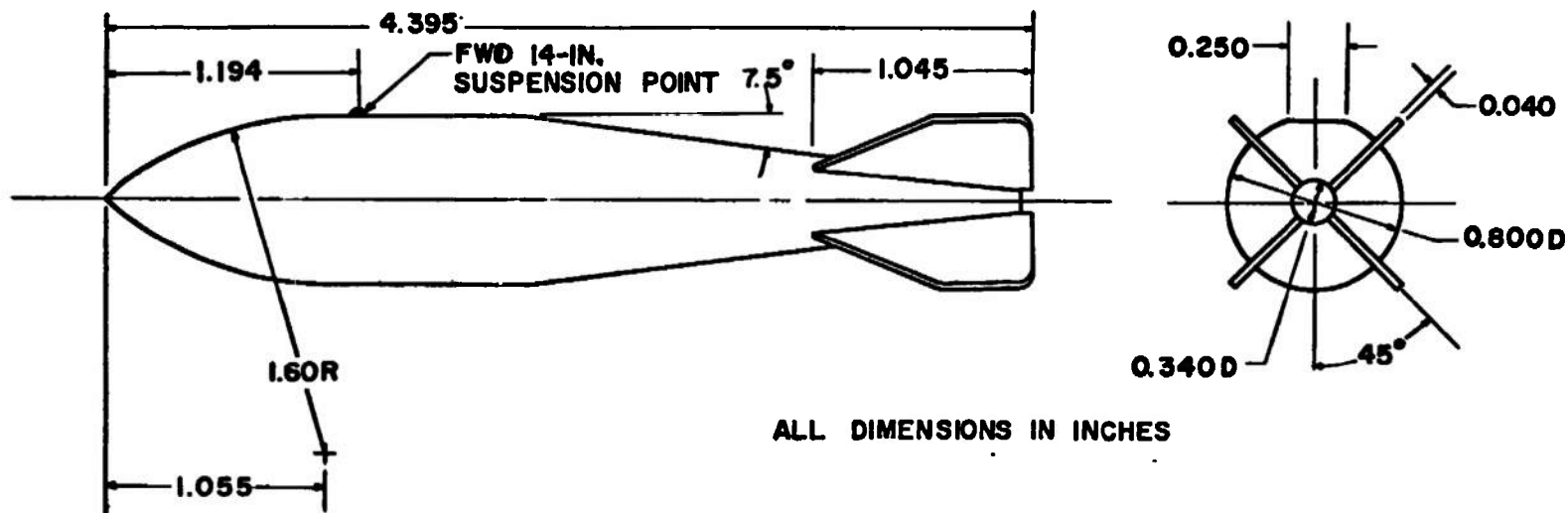
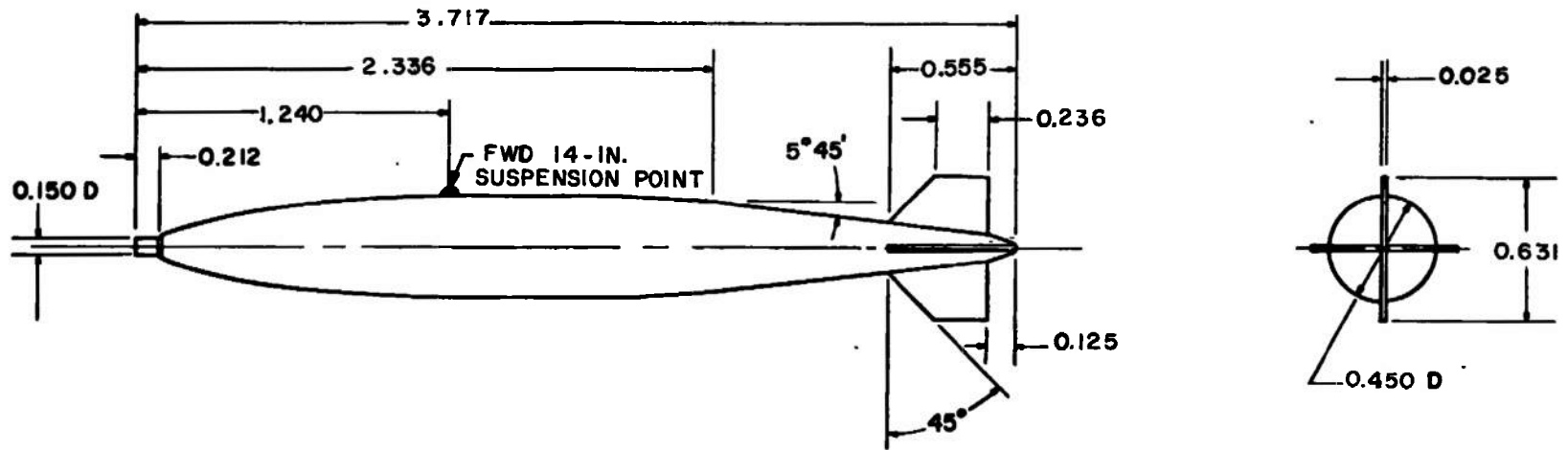


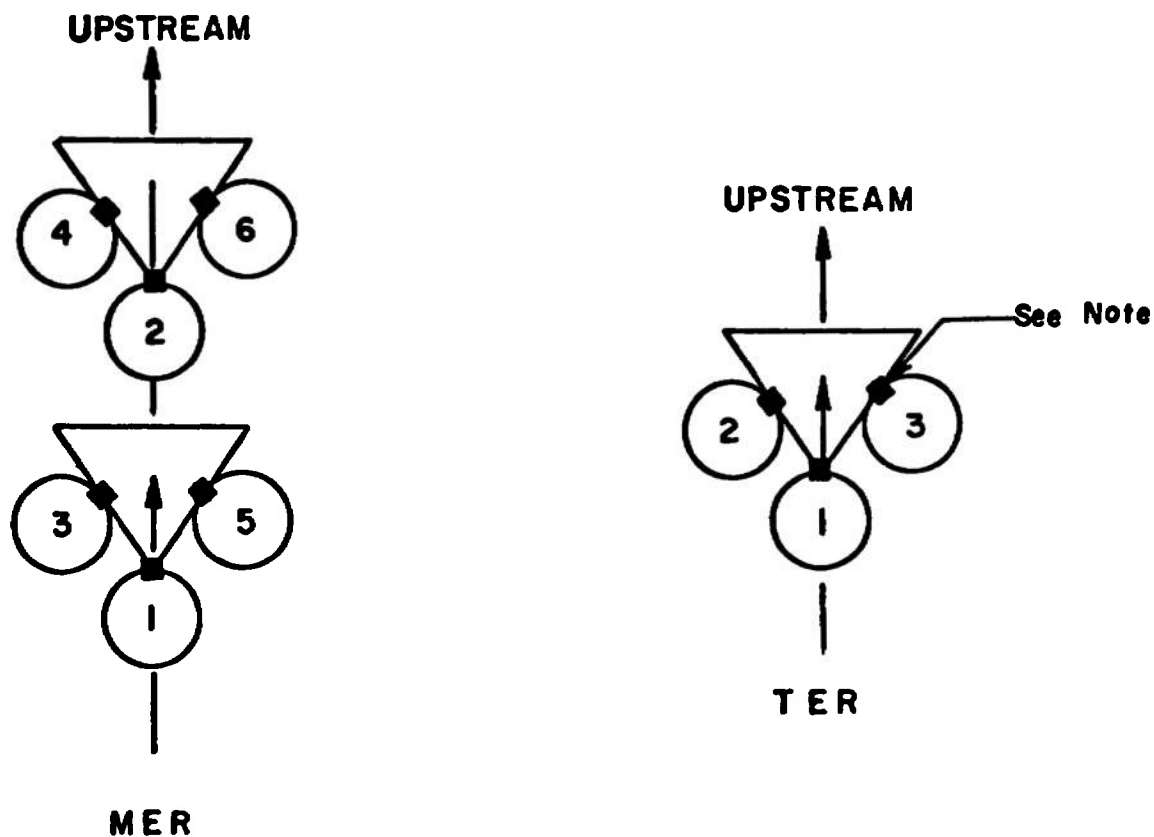
Fig. 8 Details and Dimensions of the M-117 Model



ALL DIMENSIONS IN INCHES

Fig. 9 Details and Dimensions of the MK-81 Model

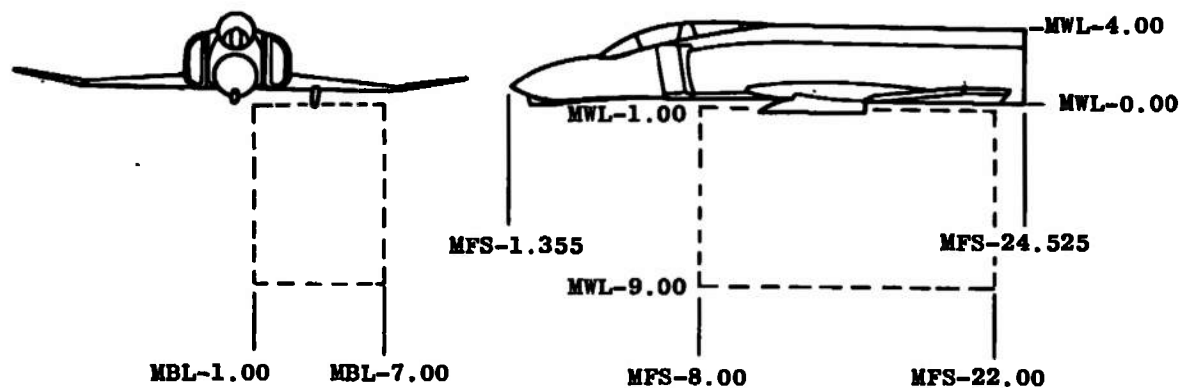
Fig. 10 Details and Dimensions of the MK-84 Model



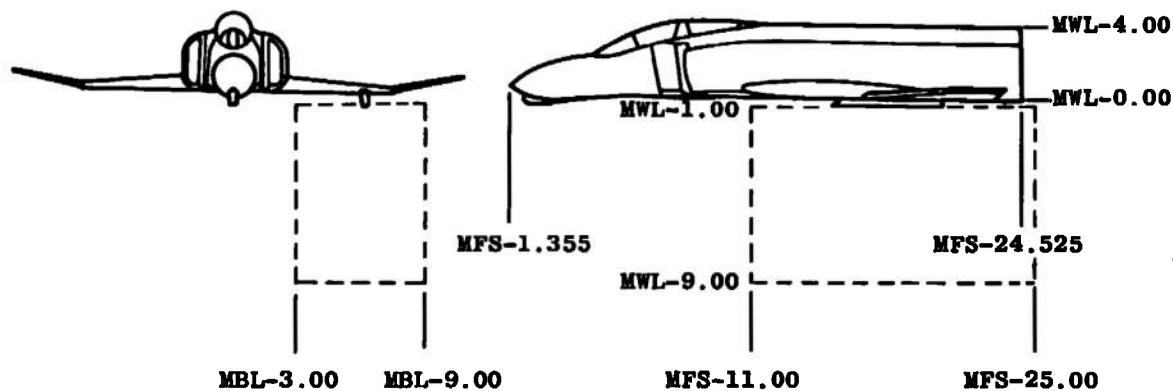
NOTE: The square indicates the orientation of the suspension lugs

TYPE RACK	STATION	ROLL ORIENTATION, deg
MER ↓	1	0
	2	0
	3	45
	4	45
	5	-45
	6	-45
TER ↓	1	0
	2	45
	3	-45

Fig. 11 Schematic of the TER and MER Store Stations and Orientations



a. Region of Inboard Survey



b. Region of Outboard Survey

Fig. 12 Sketch of the F-4C Parent Aircraft Showing Regions Surveyed

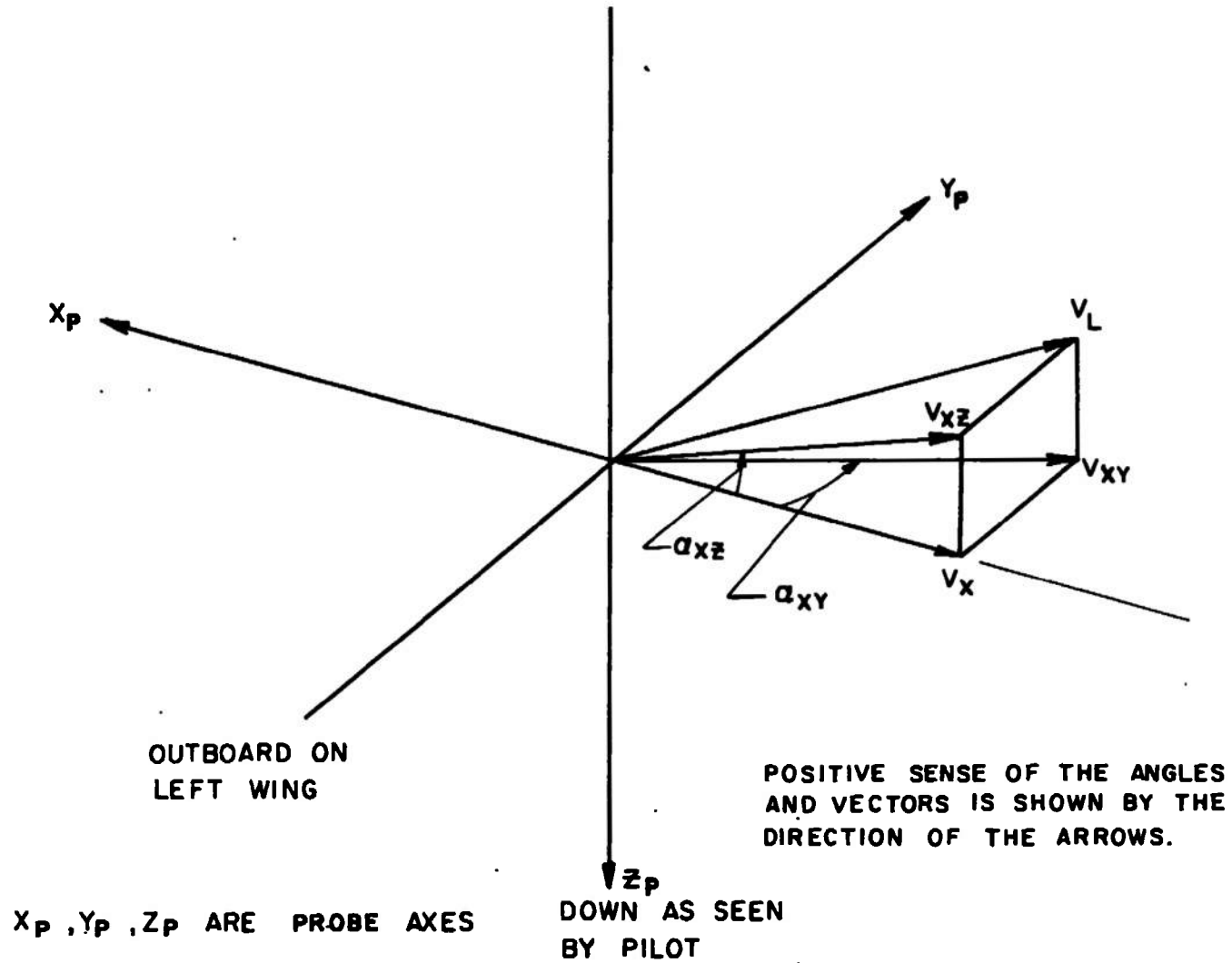
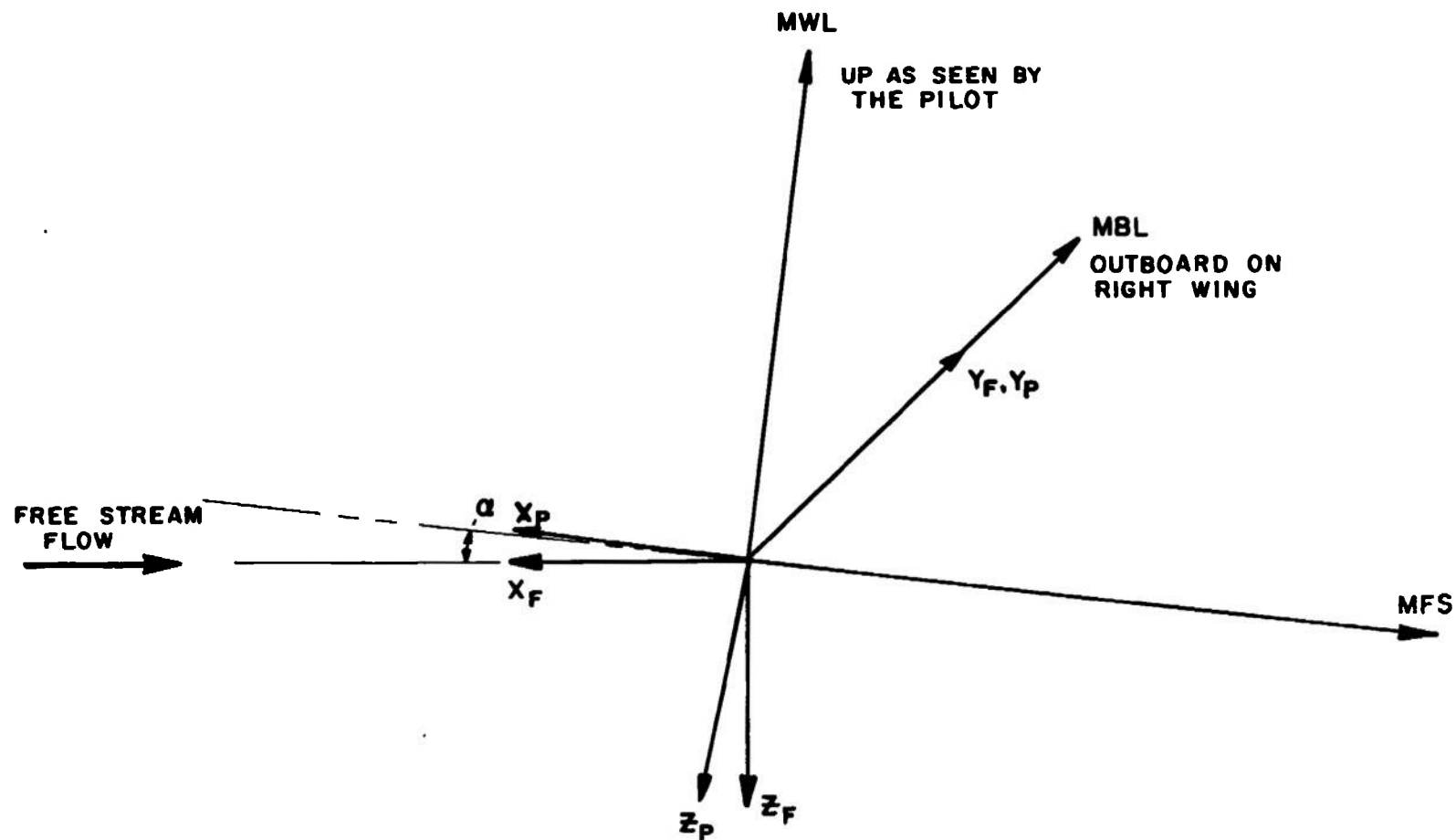
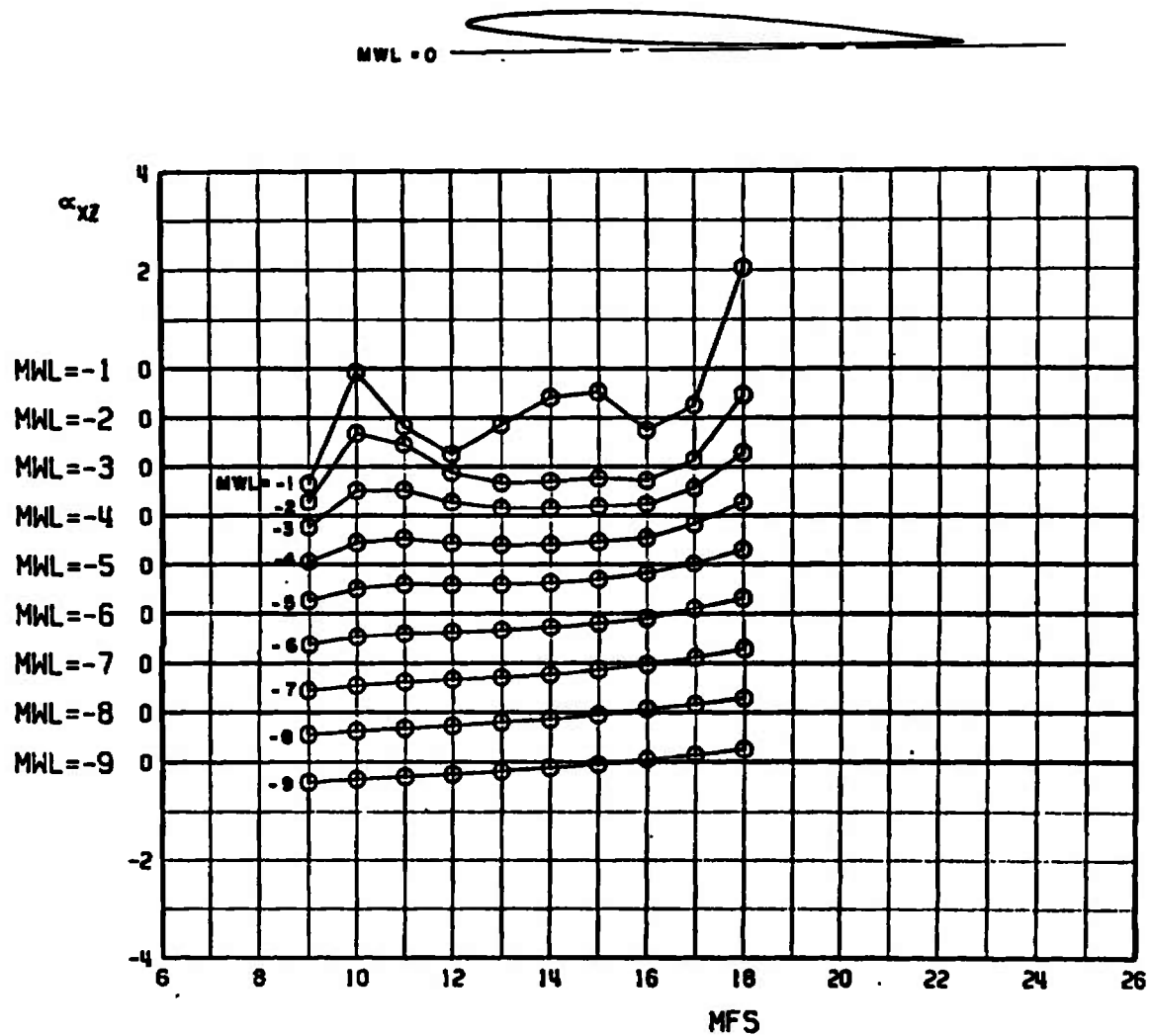


Fig. 13 Axis Systems Defining Directions and Angles for the Data



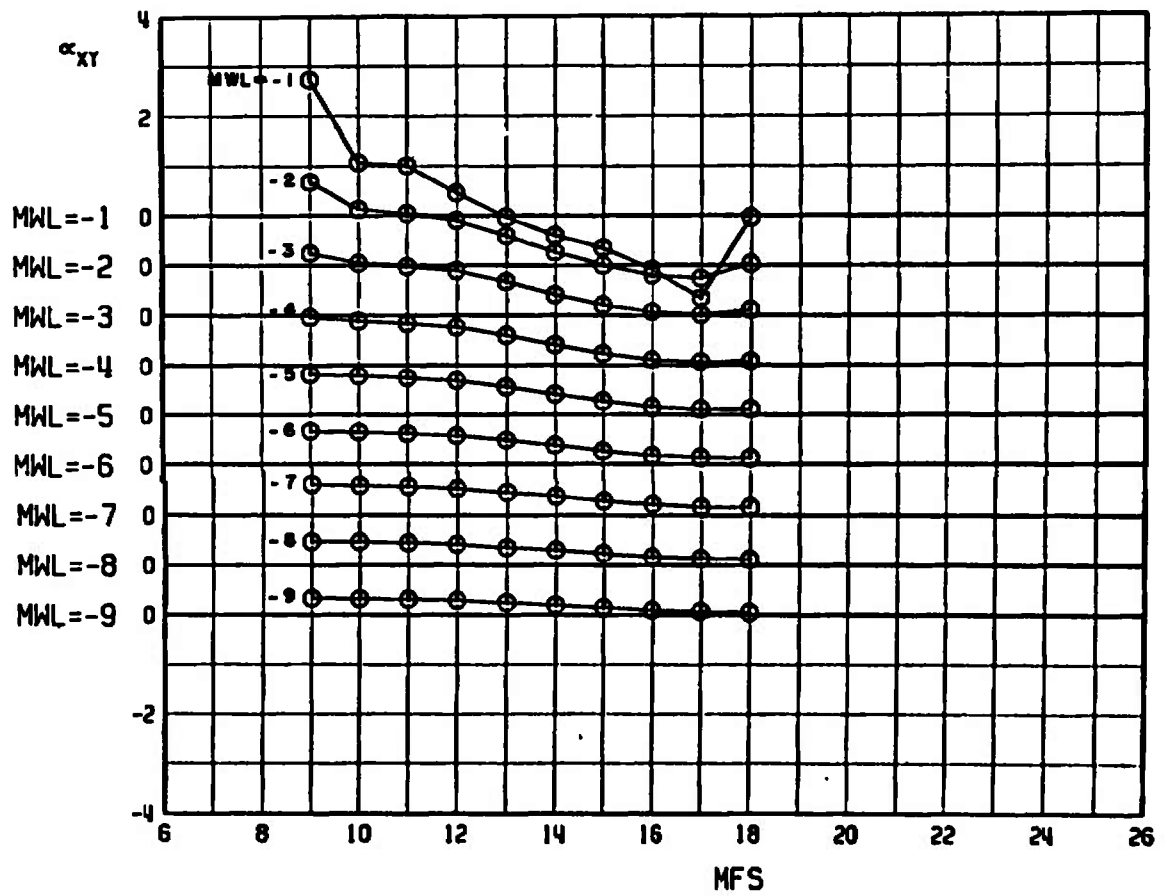
X_F, Y_F, Z_F ARE FLIGHT AXES
 MFS, MBL, MWL ARE FUSELAGE AXES
 X_P, Y_P, Z_P ARE PROBE AXES

Fig. 13 Concluded

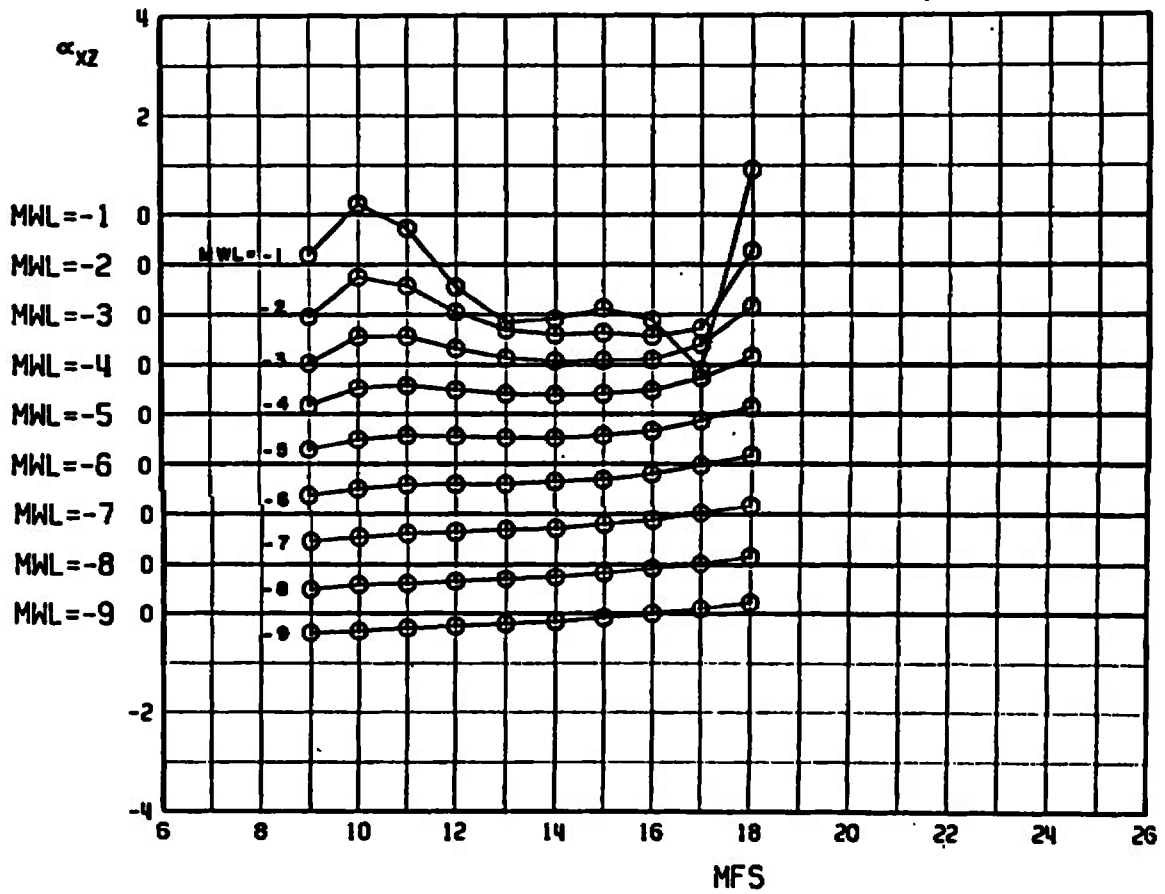


a. Upwash, MBL 3

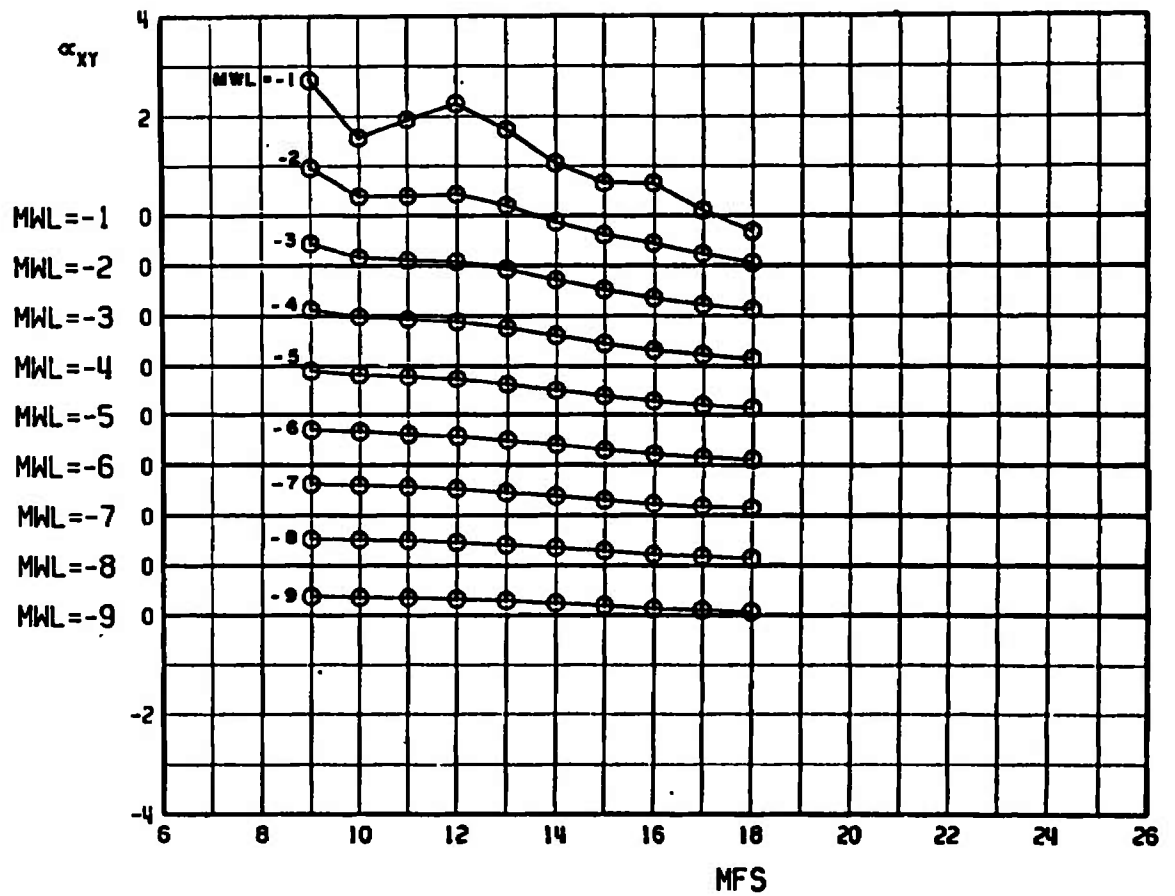
Fig. 14 Flow-Field Measurements beneath the Clean Wing at an Aircraft Angle of 0.3 deg, Configuration 1R



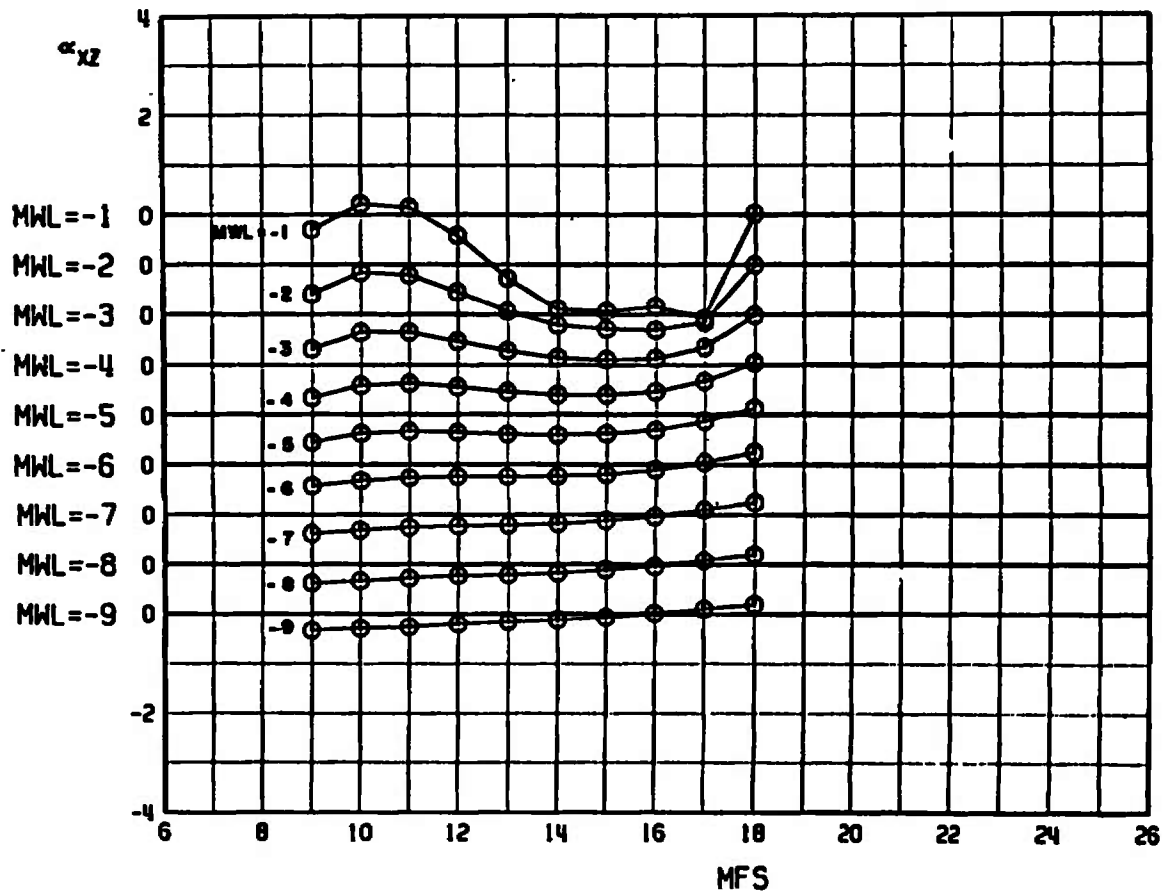
b. Sidewash, MBL 3
Fig. 14 Continued



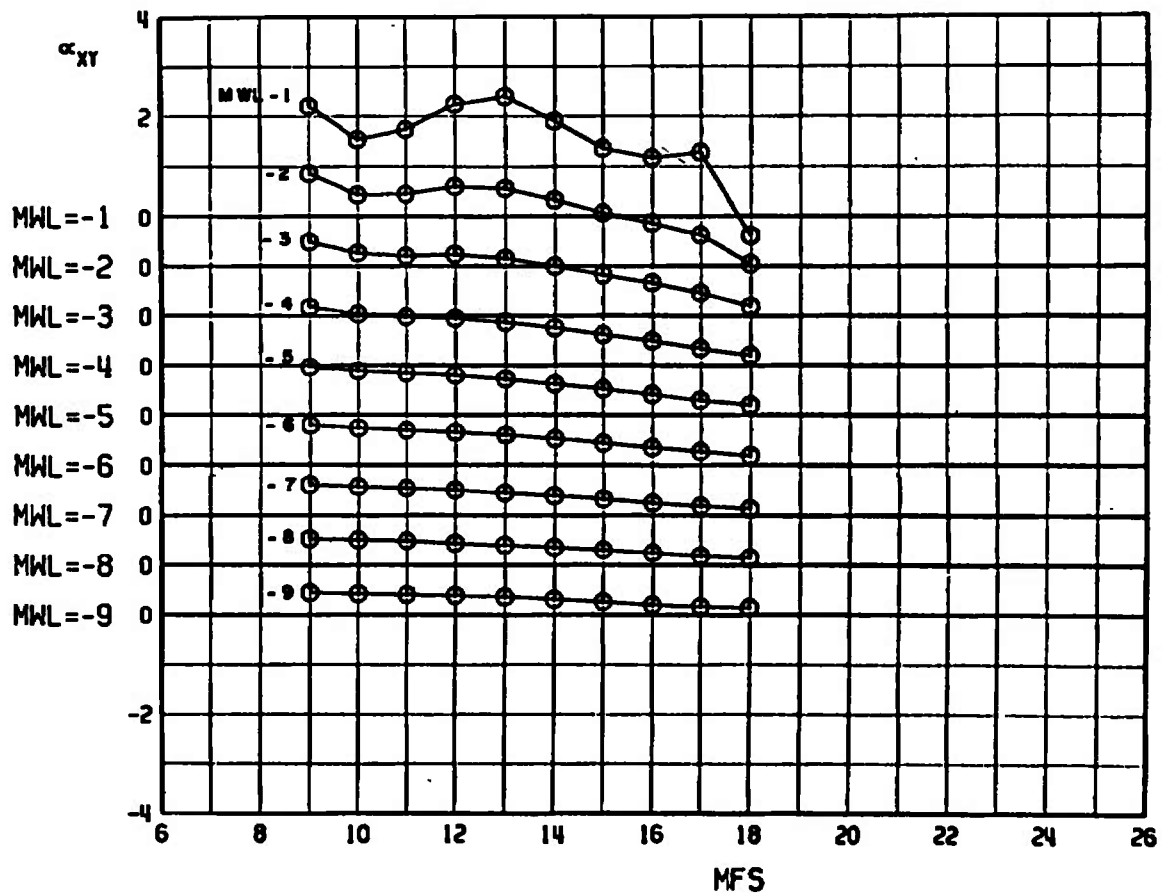
c. Upwash, MBL 4
Fig. 14 Continued



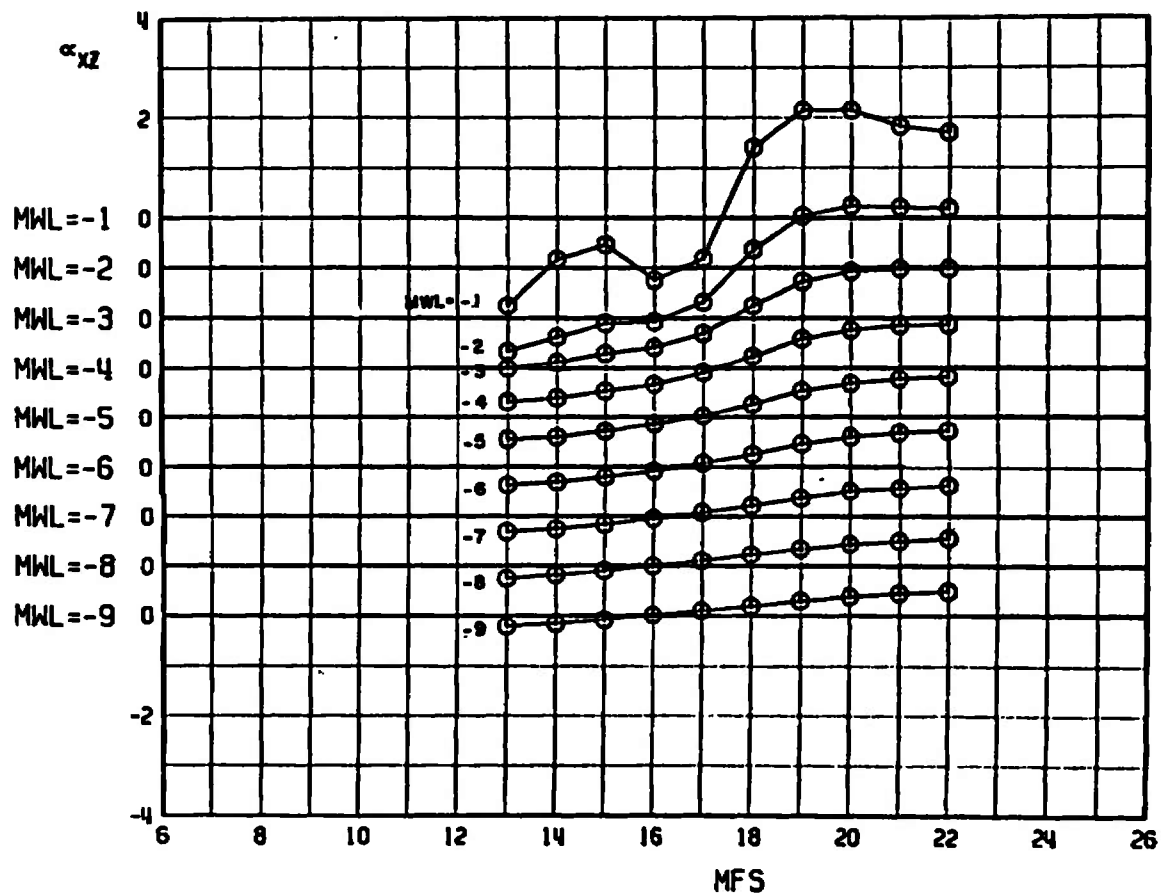
d. Sidewash, MBL 4
Fig. 14 Continued



e. Upwash MBL 5
Fig. 14 Continued

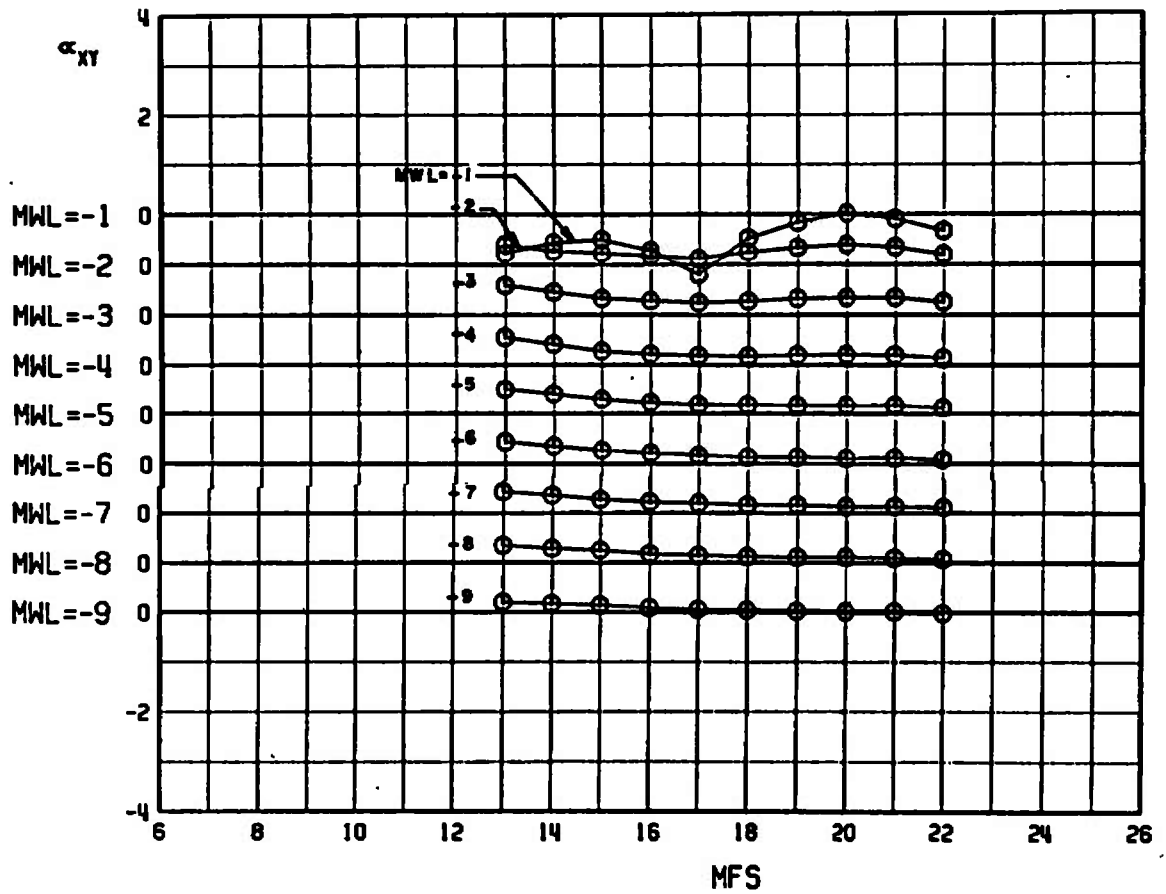


f. Sidewash, MBL 5
Fig. 14 Concluded

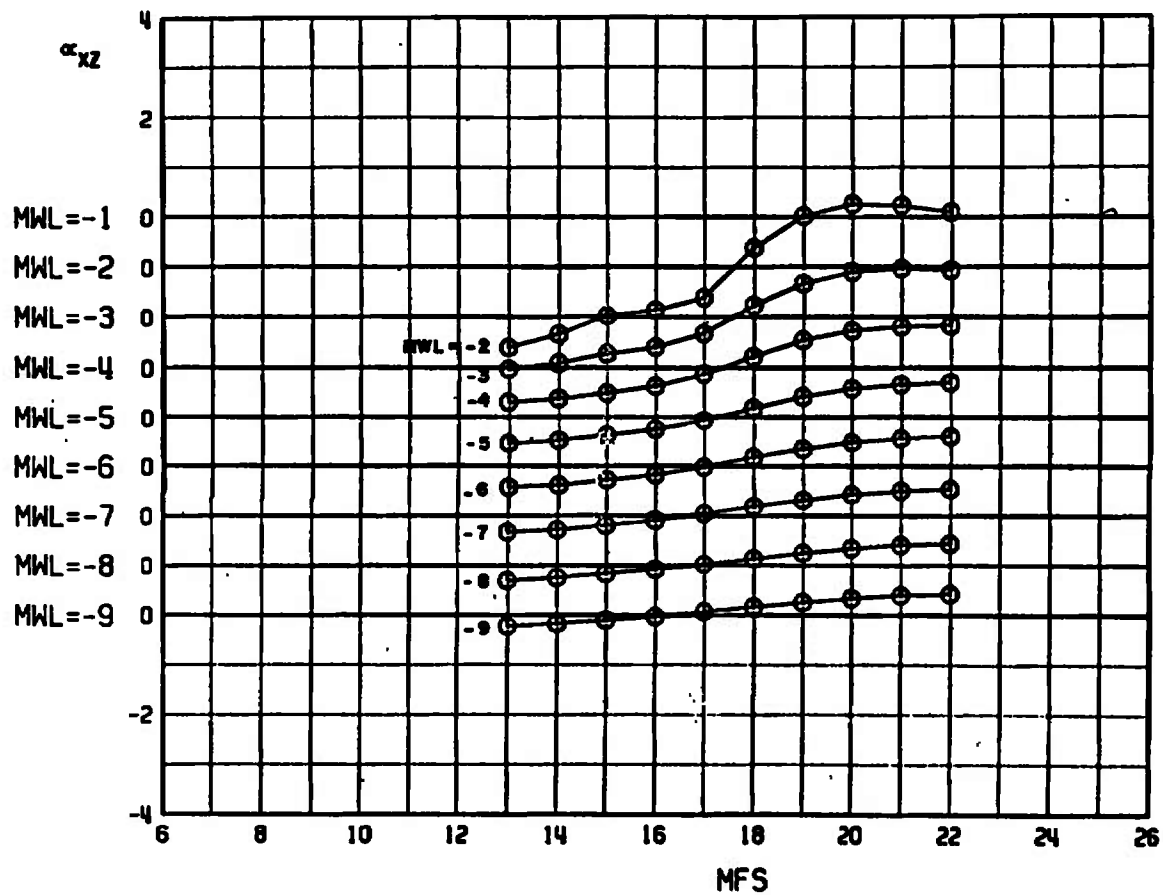


a. Upwash, MBL 3

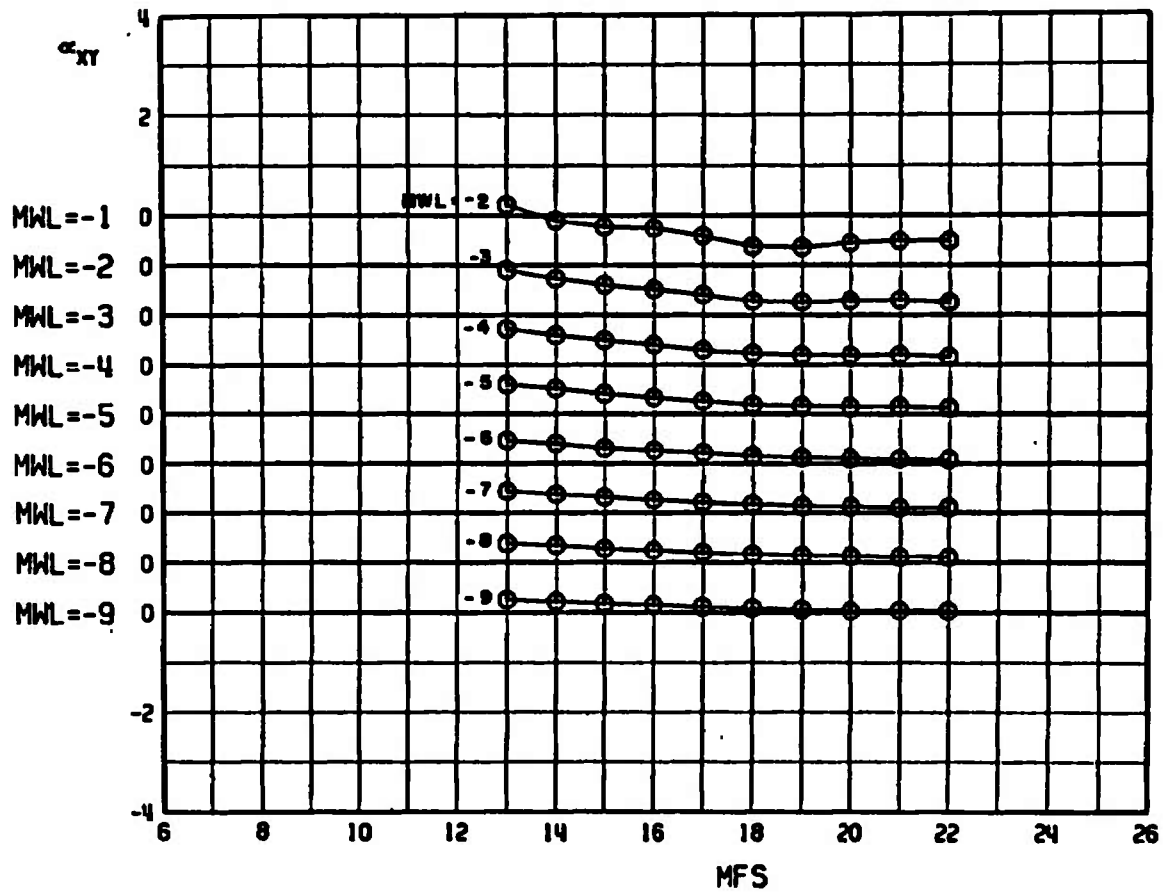
Fig. 15 Flow-Field Measurements beneath the Empty Inboard Pylon at an Aircraft Angle of 0.30 deg, Configuration 2R



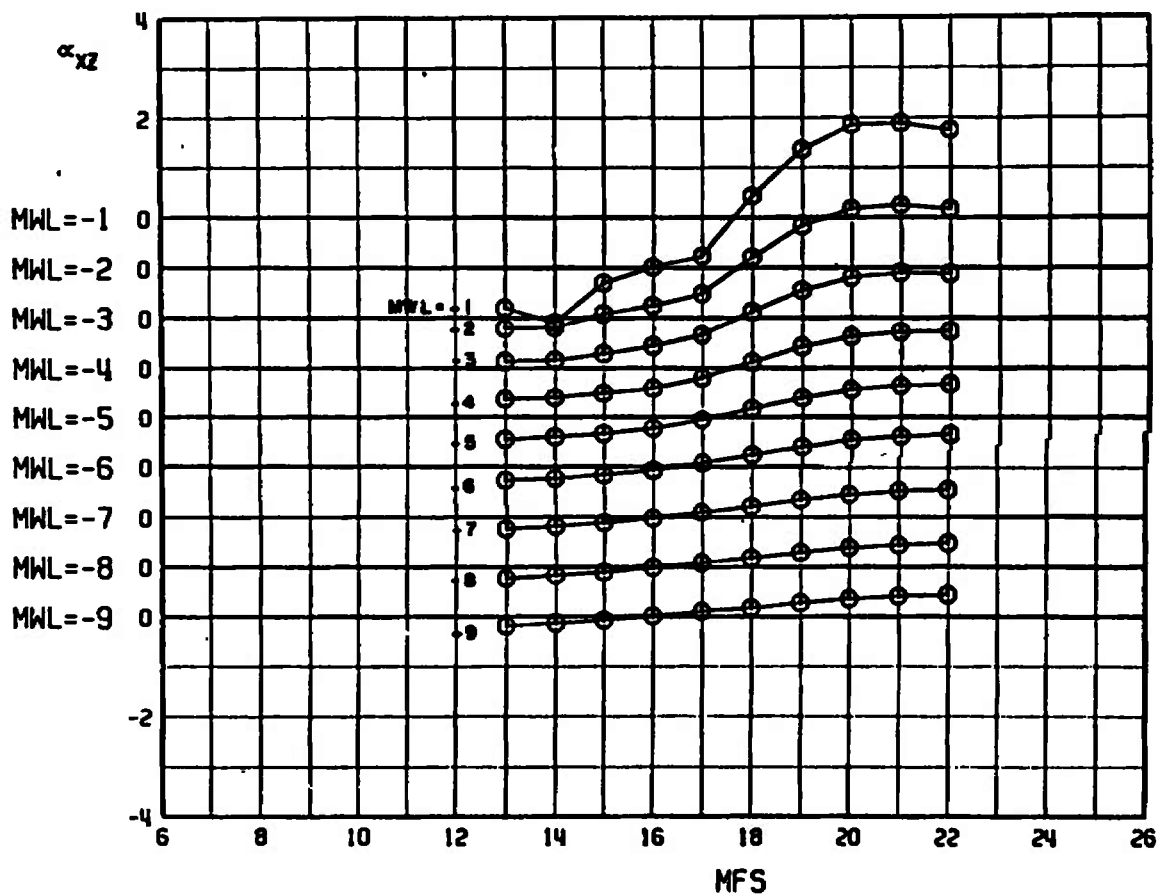
b. Sidewash, MBL 3
Fig. 15 Continued



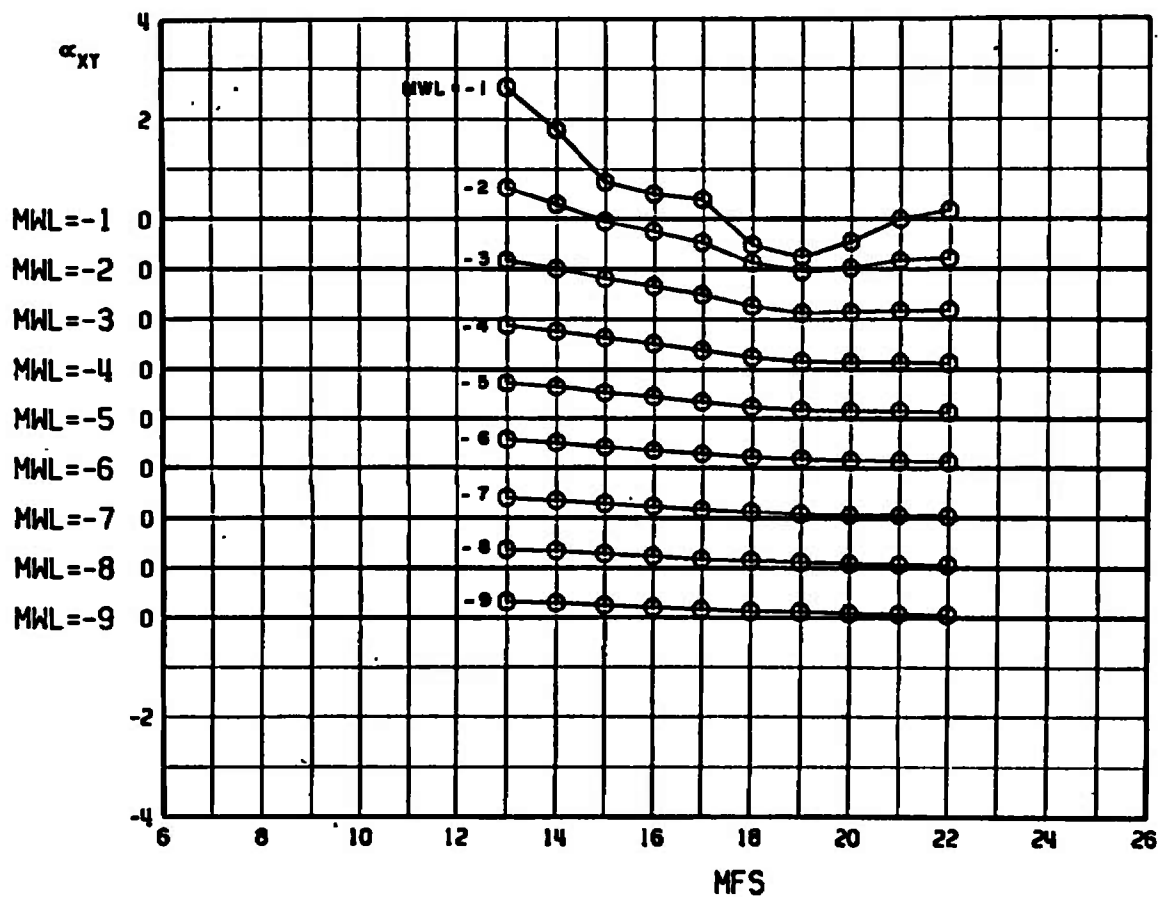
c. Upwash, MBL 4
Fig. 15 Continued



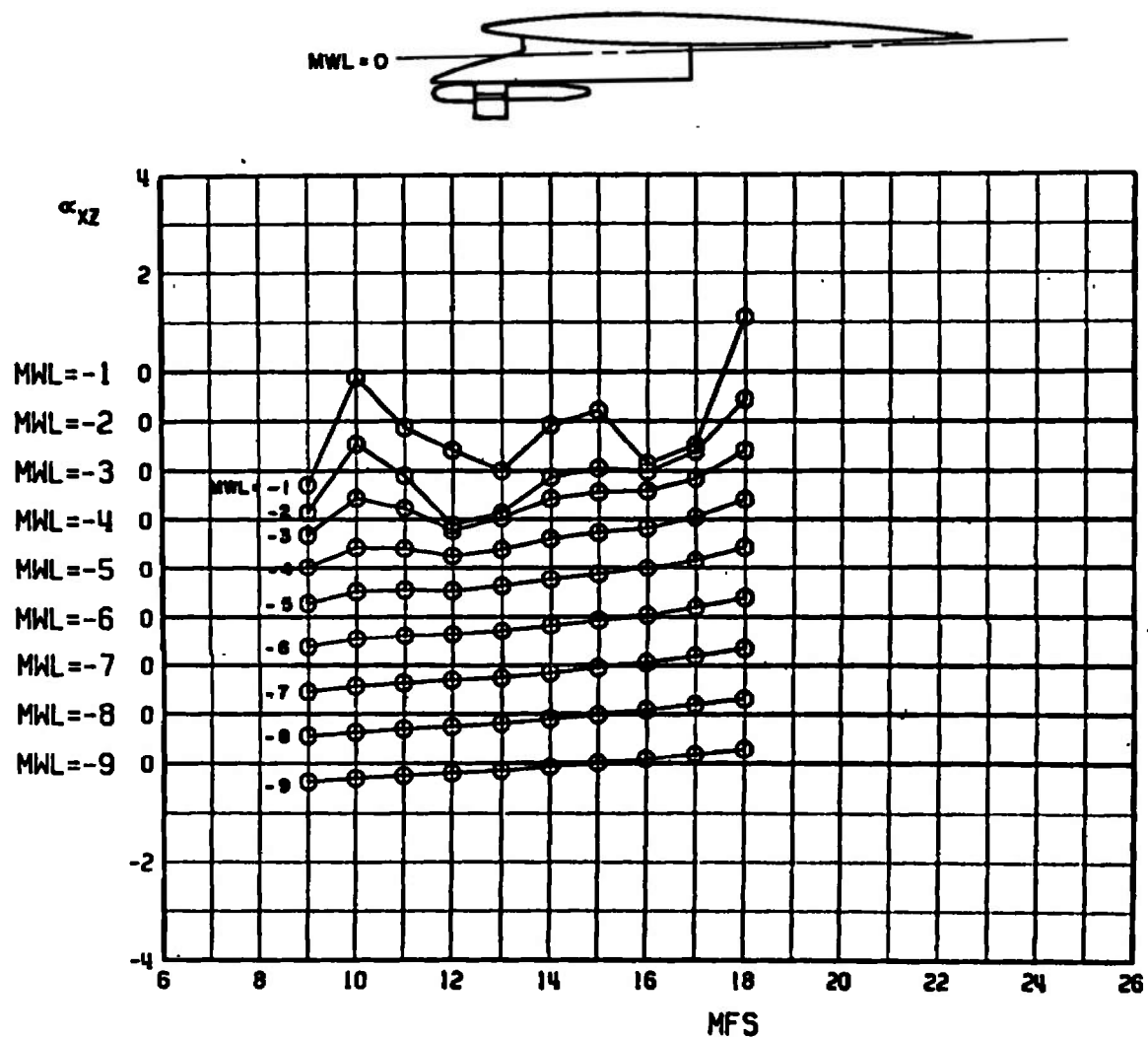
d. Sidewash, MBL 4
Fig. 15 Continued



e. Upwash, MBL 5
Fig. 15 Continued

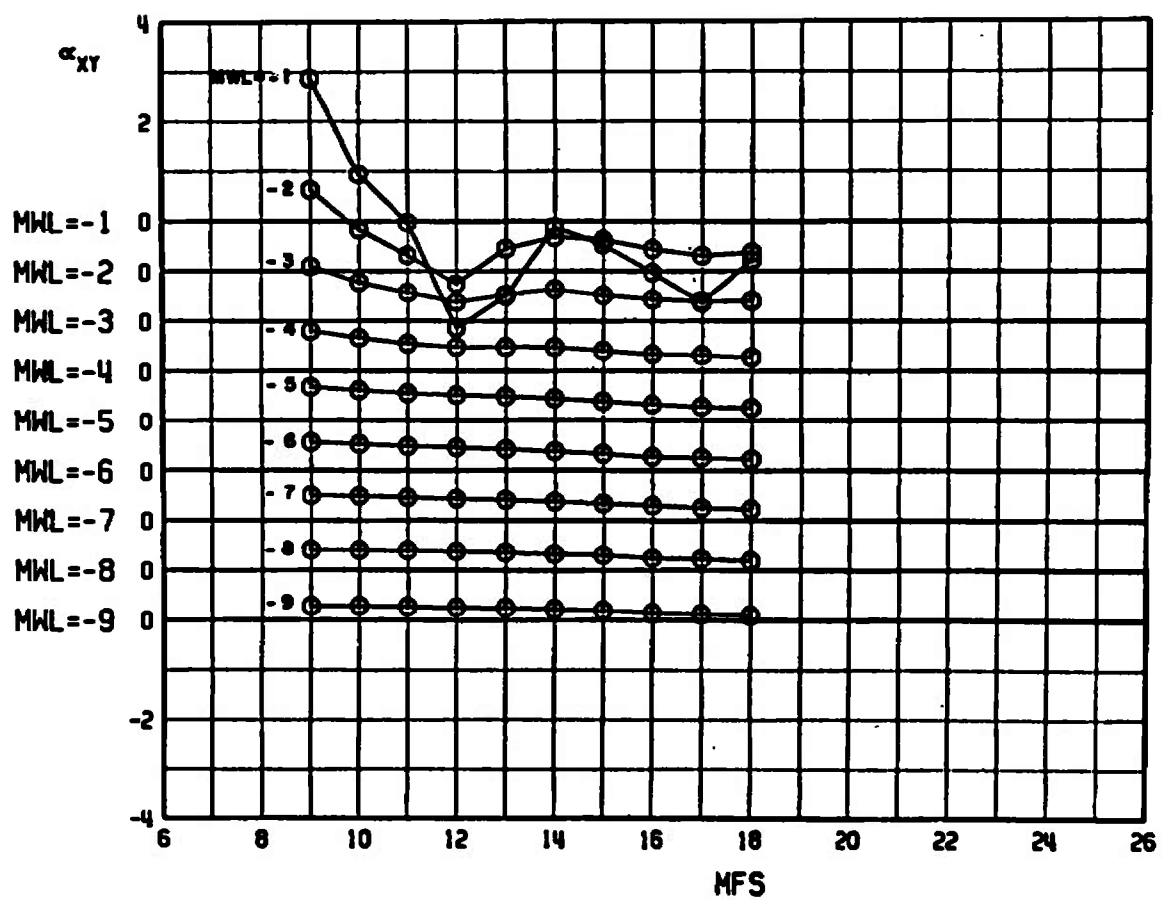


f. Sidewash, MBL 5
Fig. 15 Concluded

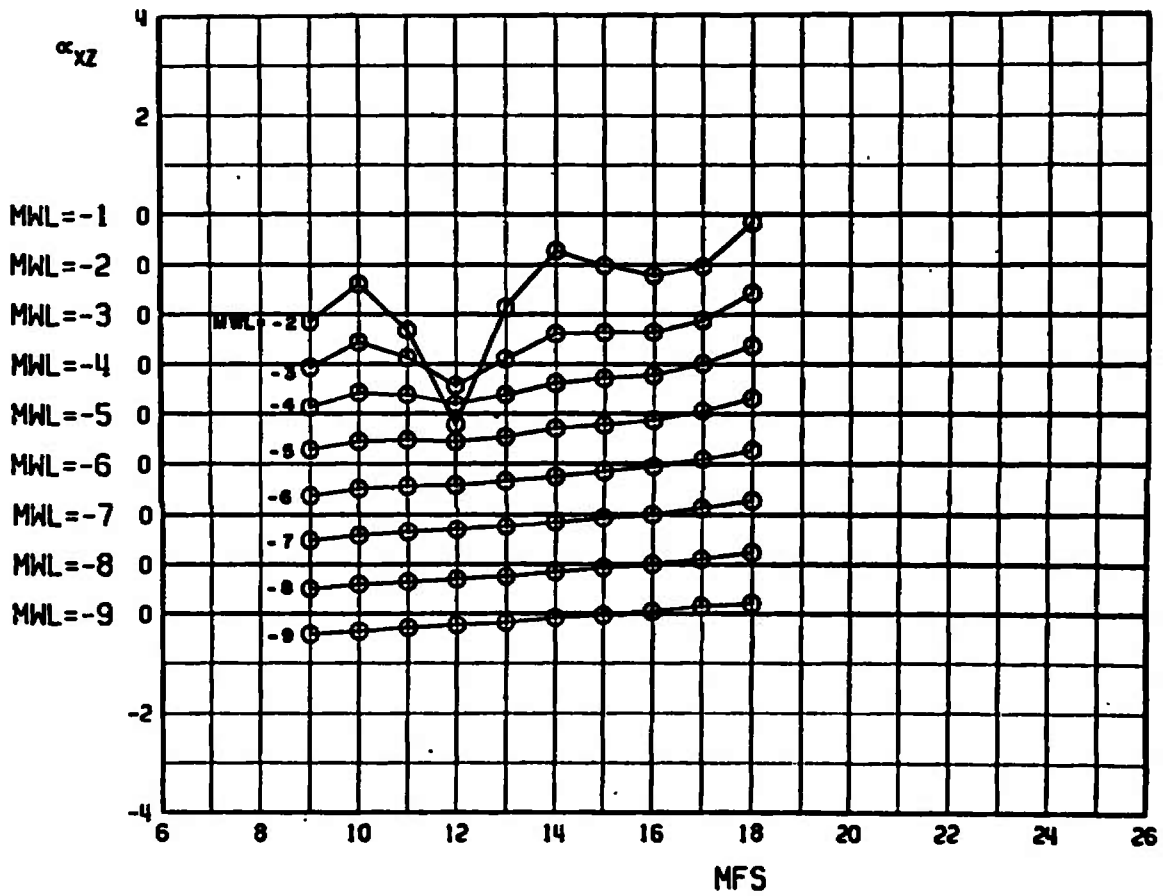


a. Upwash, MBL 3

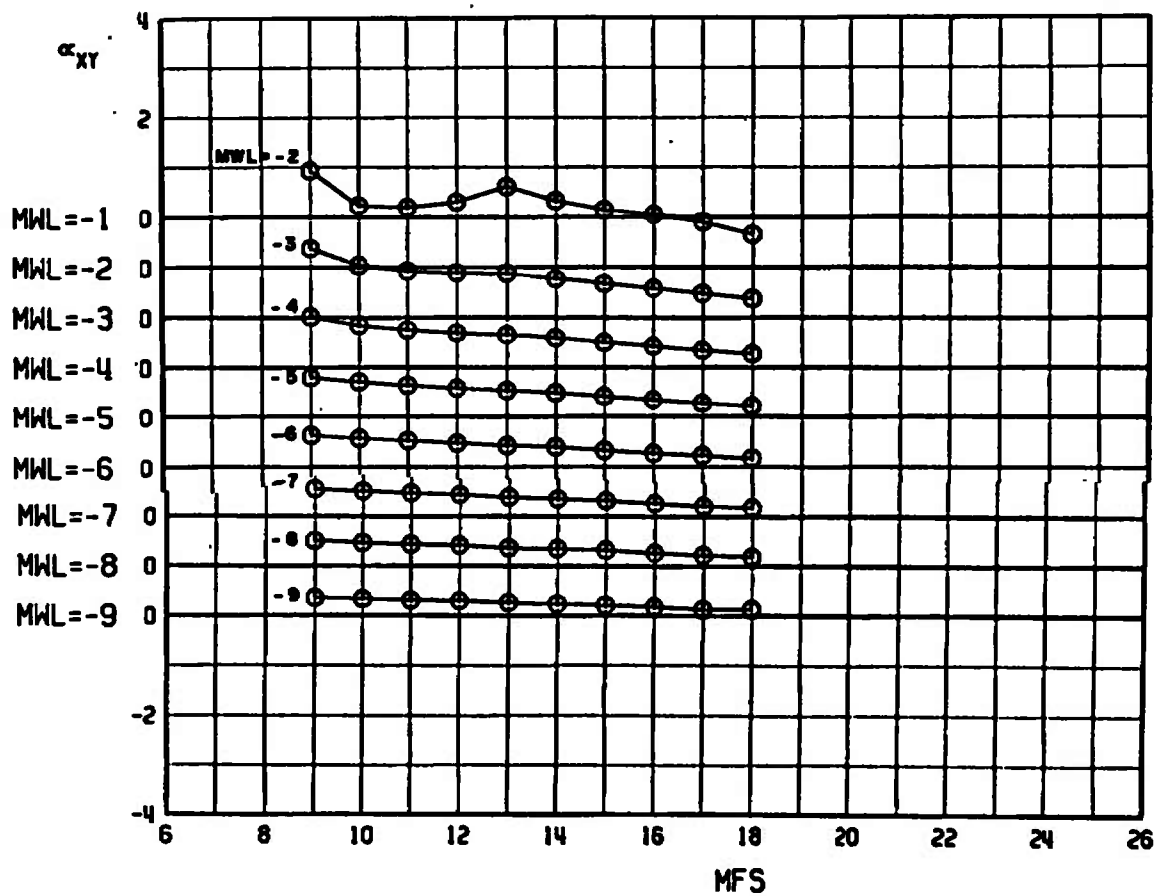
Fig. 16 Flow-Field Measurements beneath the Inboard Pylon and TER at an Aircraft Angle of 0.3 deg, Configuration 3R



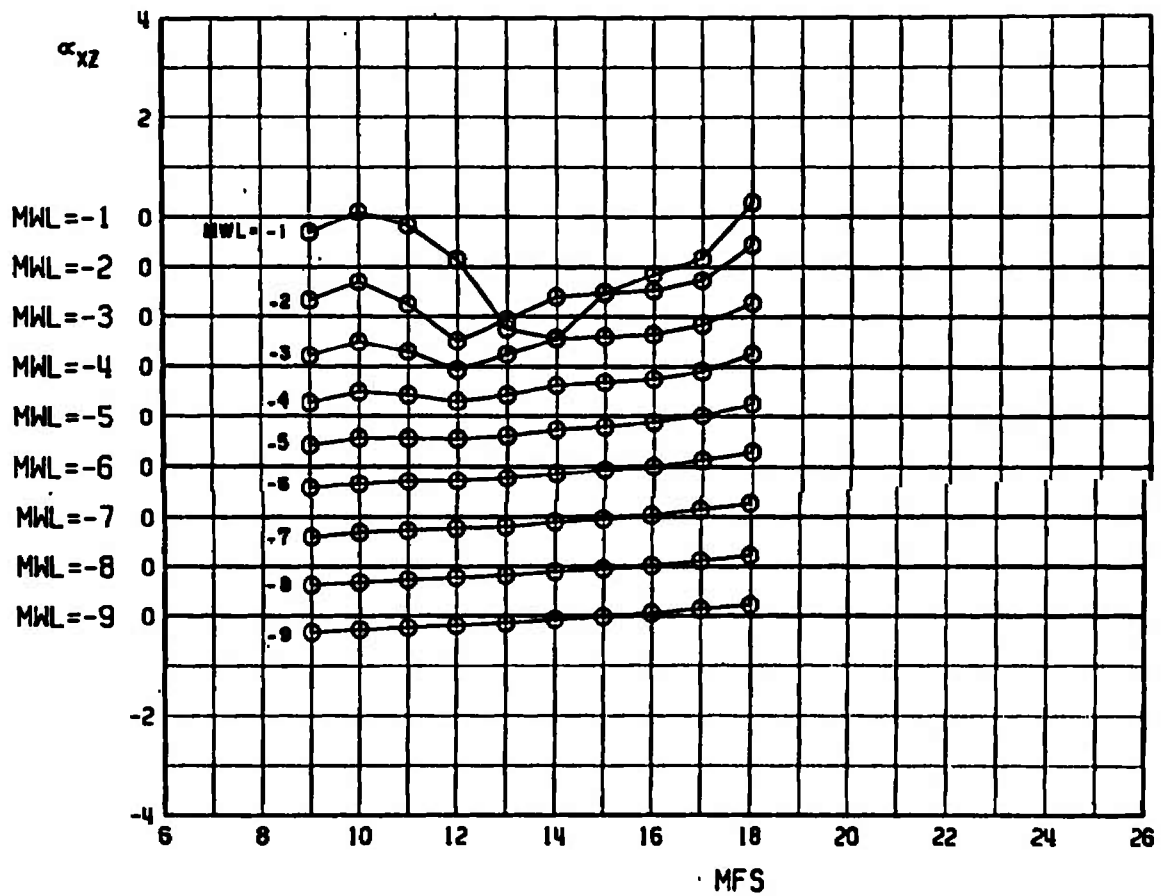
b. Sidewash, MBL 3
Fig. 16 Continued



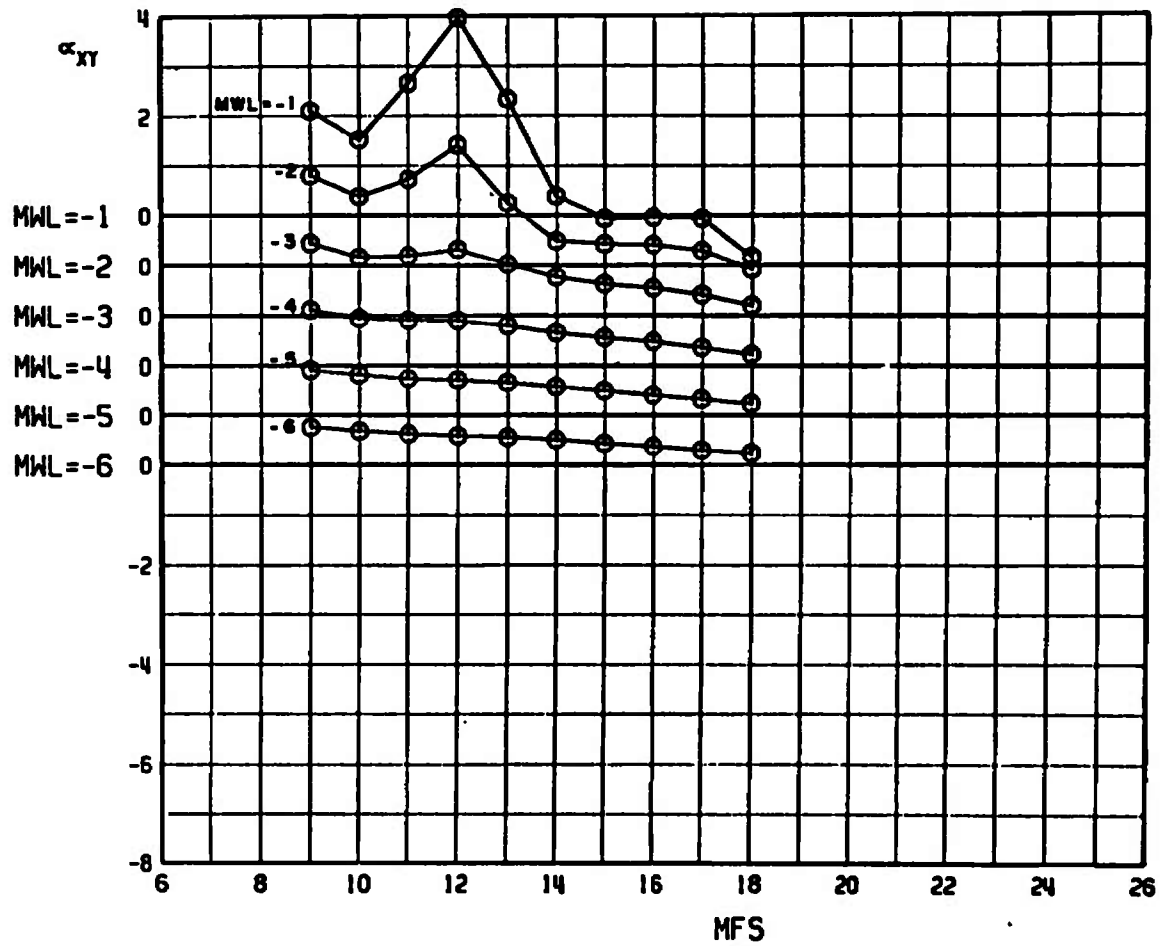
c. Upwash, MBL 4
Fig. 16 Continued



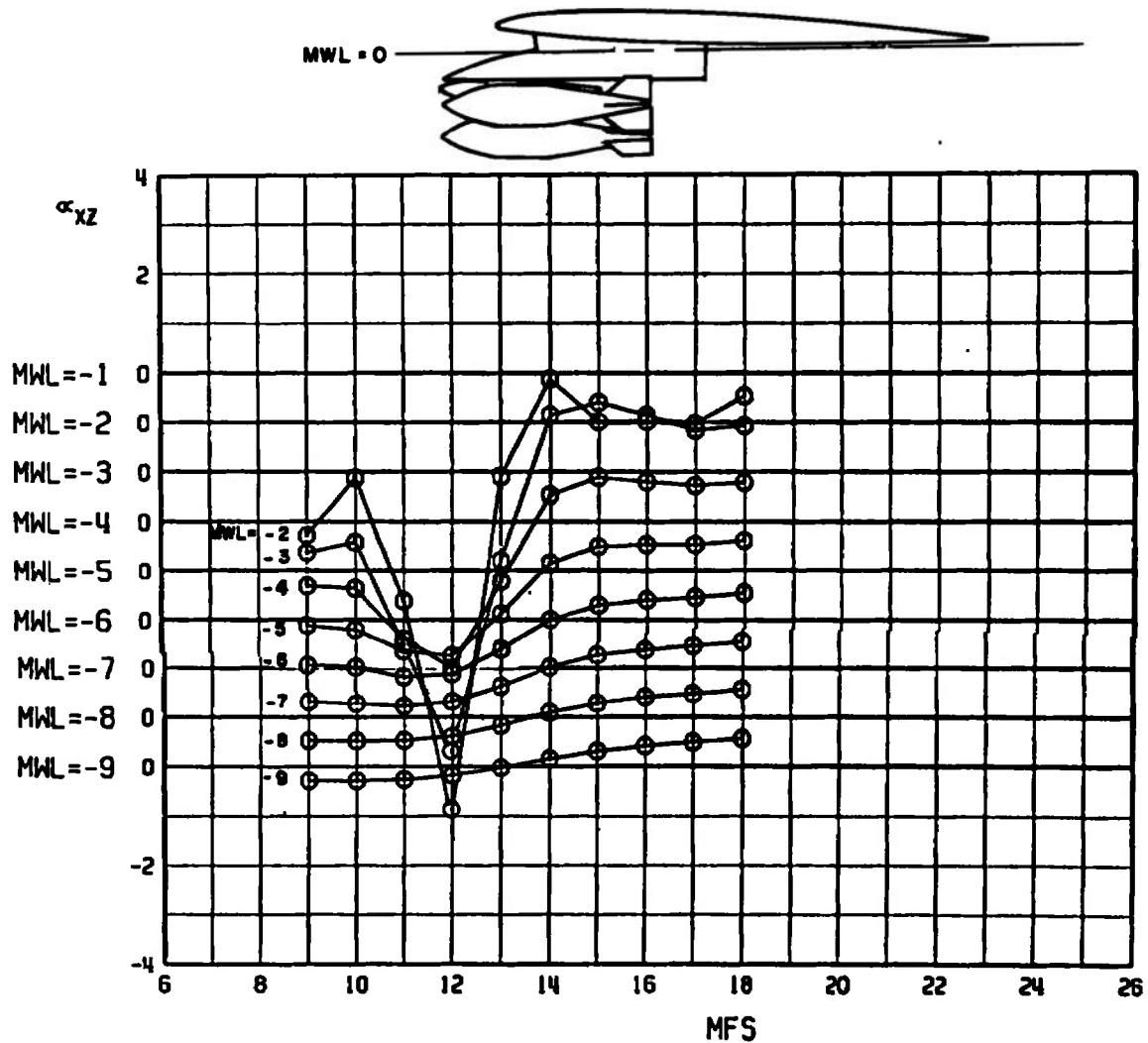
d. Sidewash, MBL 4
Fig. 16 Continued



e. Upwash, MBL 5
Fig. 16 Continued

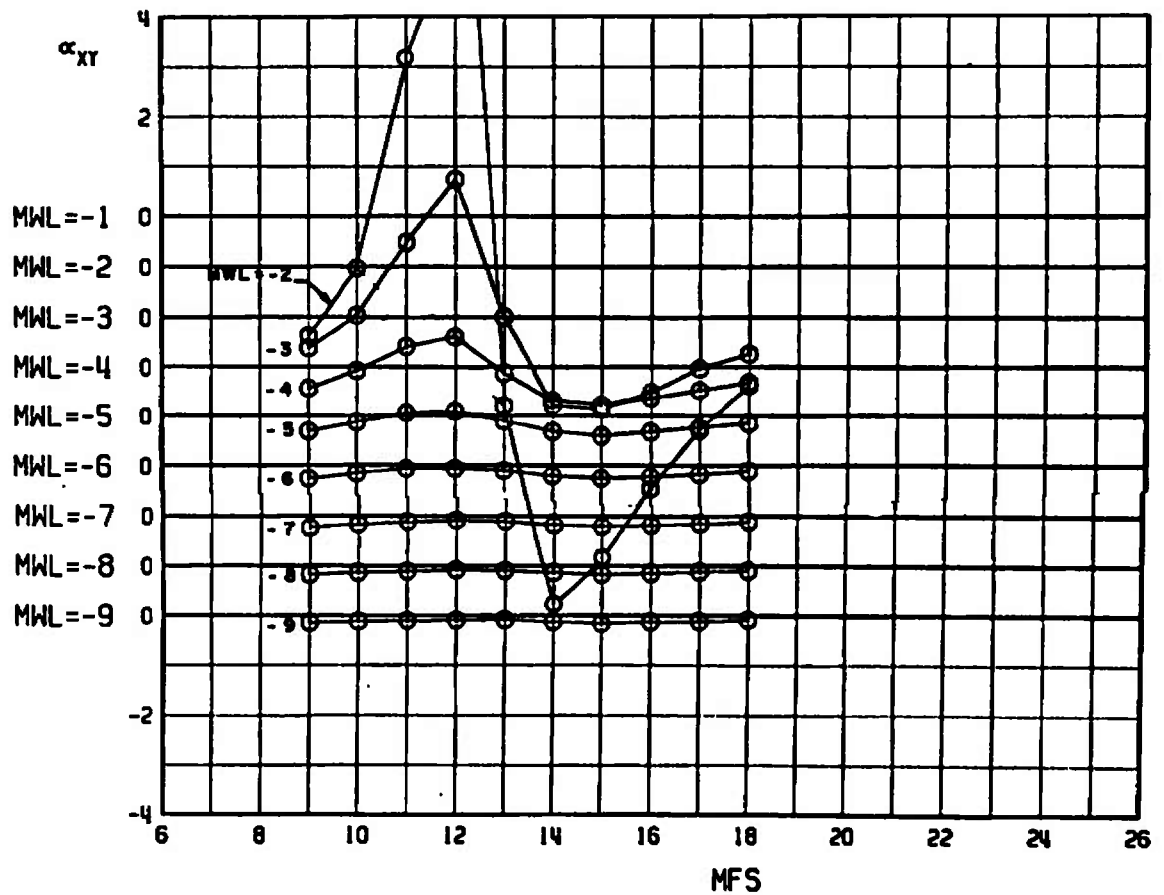


f. Sidewash, MBL 5
Fig. 16 Concluded

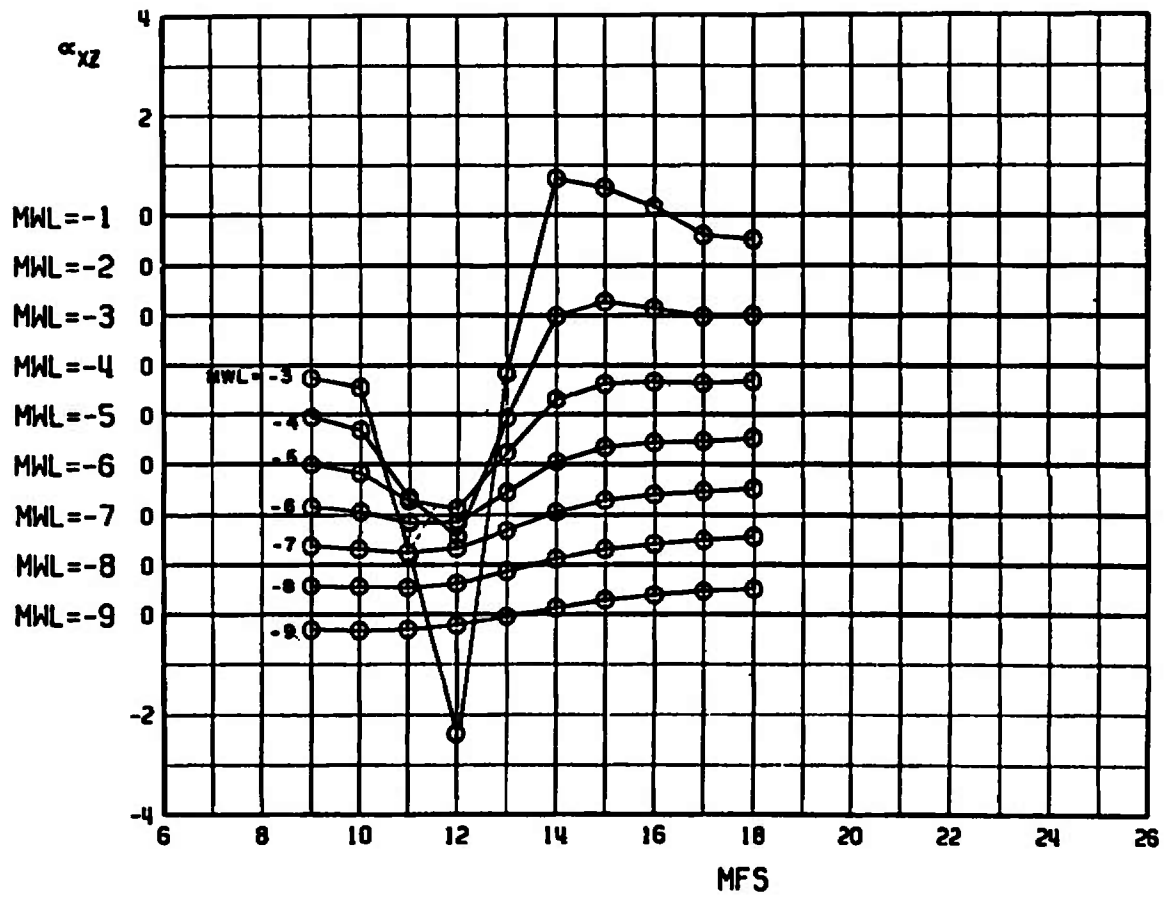


a. Upwash, MBL 3

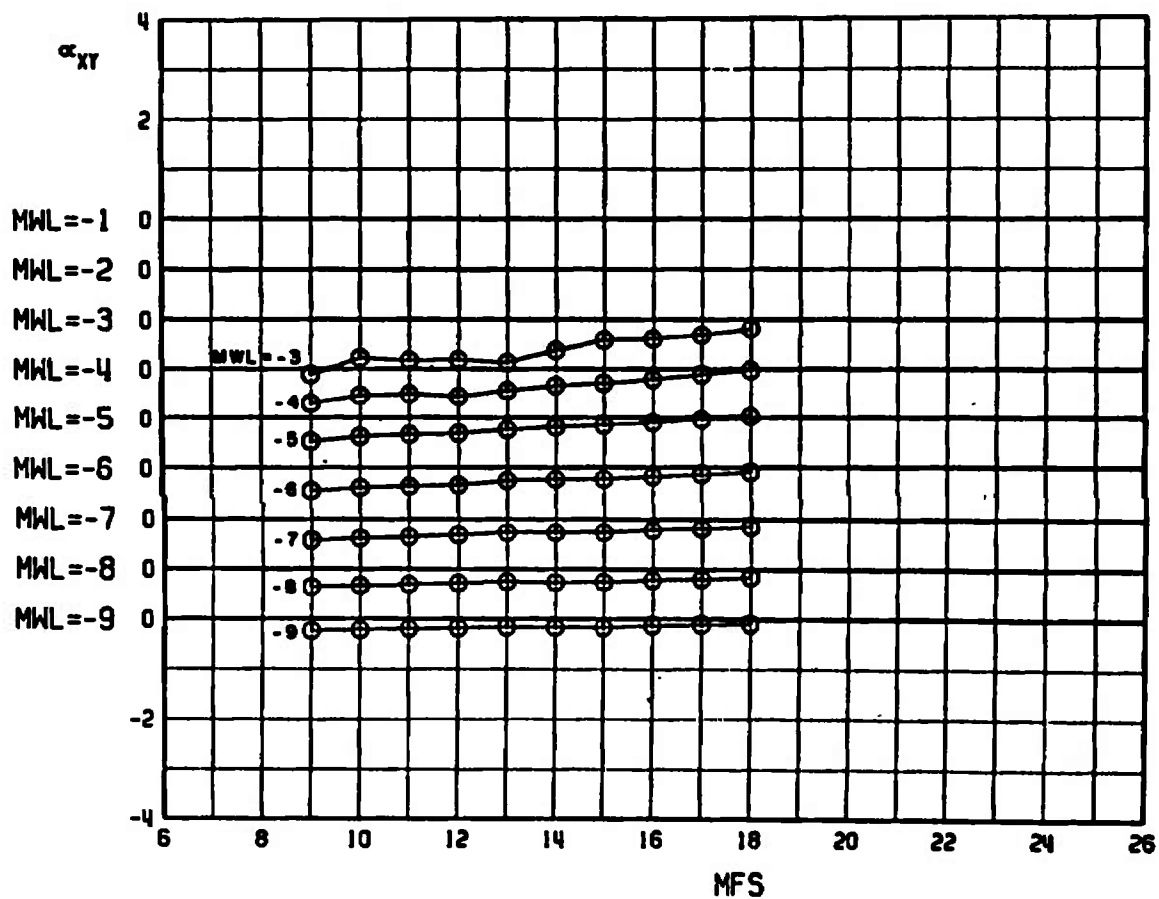
Fig. 17 Flow-Field Measurements beneath the Inboard Pylon, TER, and Three M-117 Stores at an Aircraft Angle of 0.3 deg, Configuration 4L



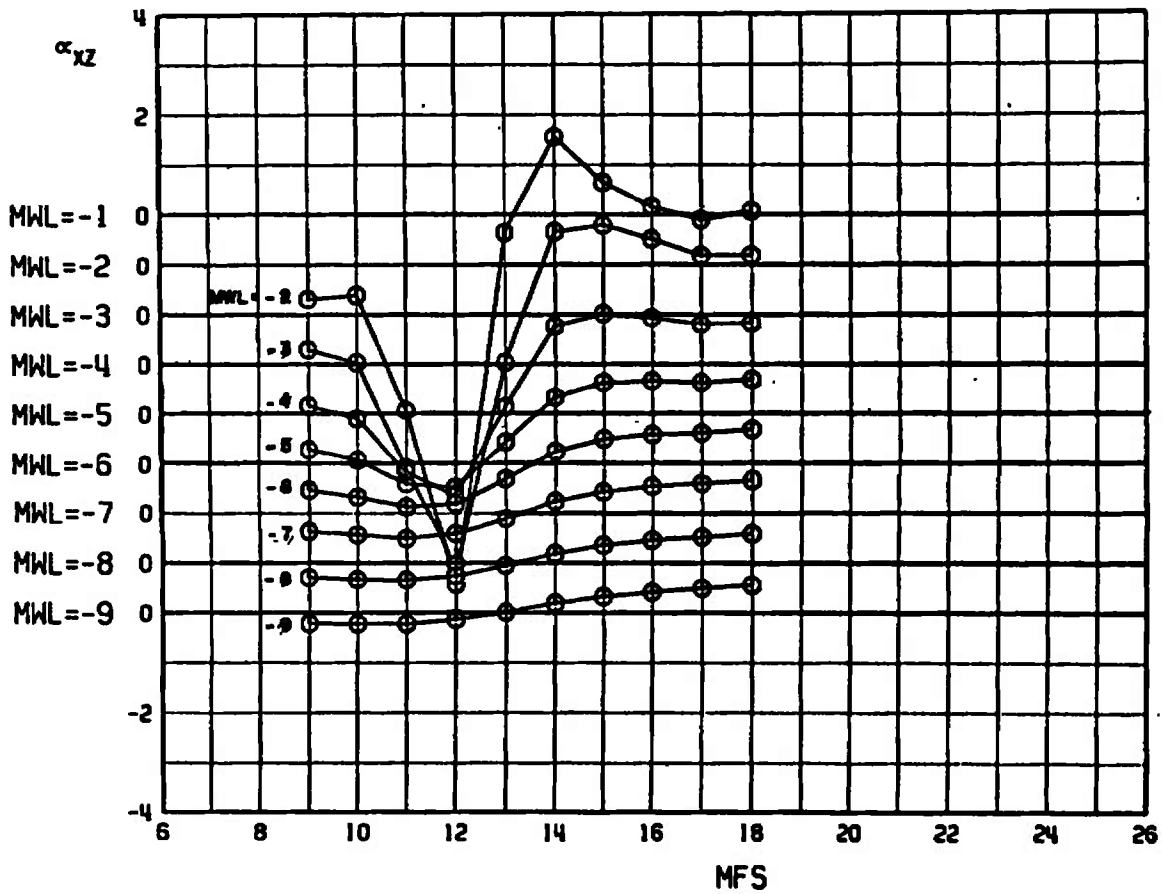
b. Sidewash, MBL 3
Fig. 17 Continued



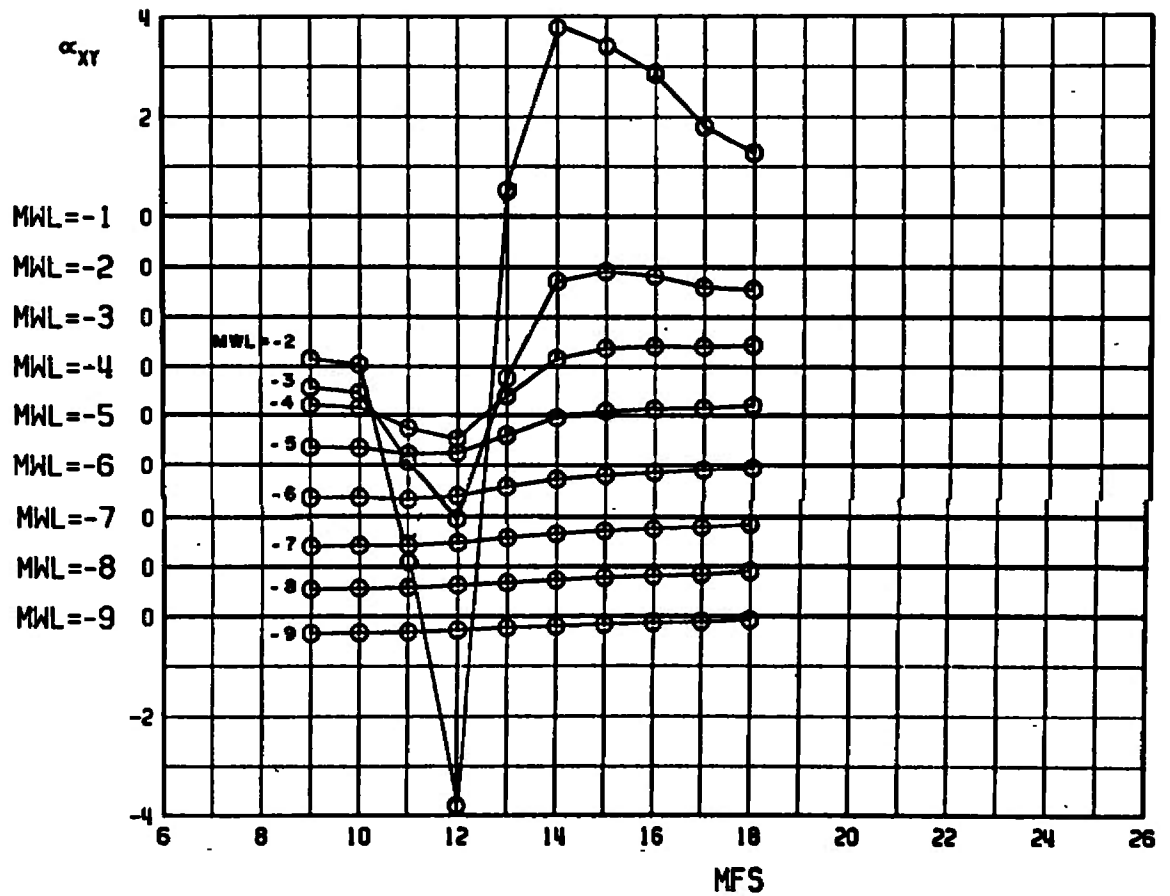
c. Upwash, MBL 4
Fig. 17 Continued



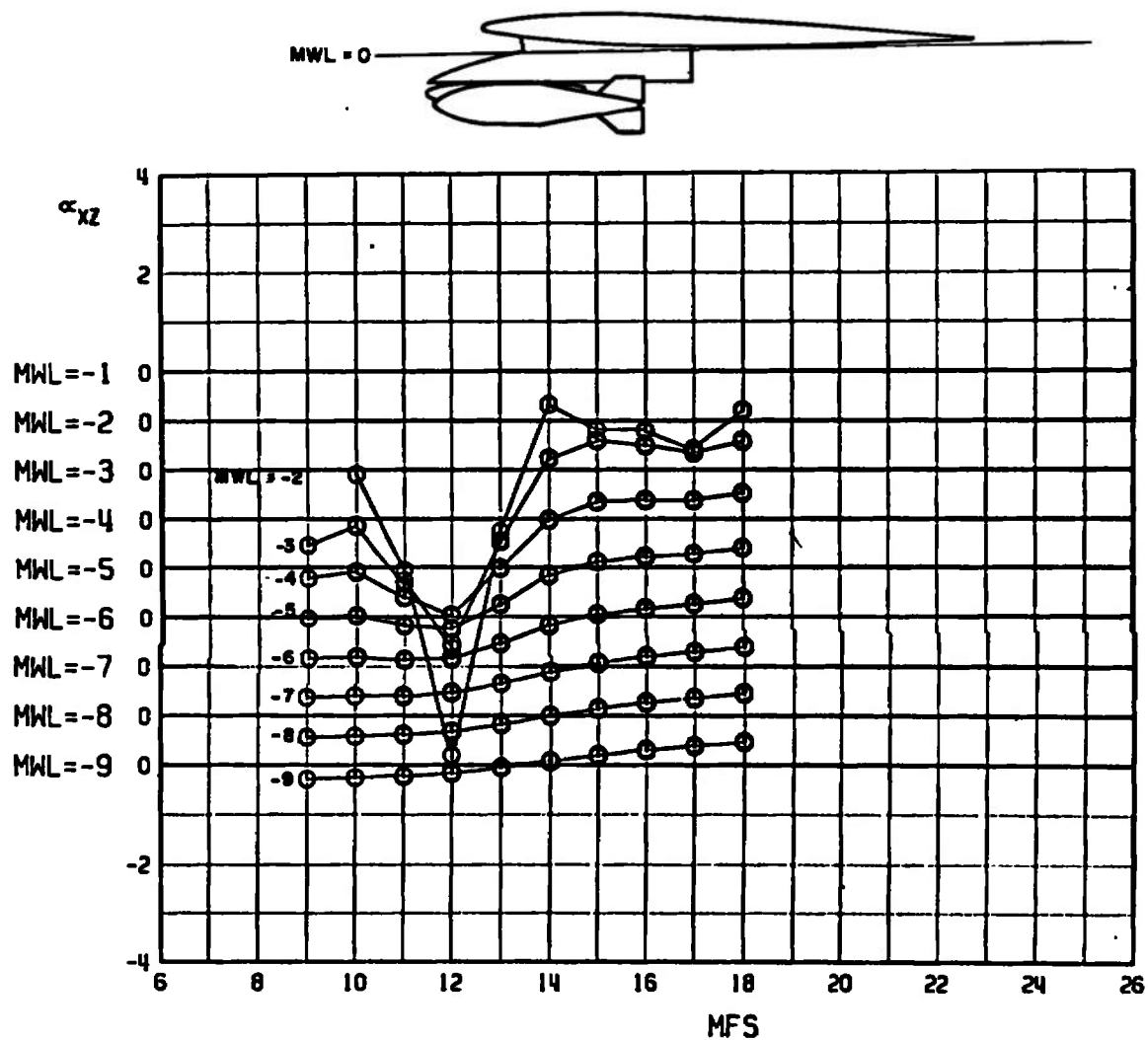
d. Sidewash, MBL 4
Fig. 17 Continued



e. Upwash, MBL 5
Fig. 17 Continued

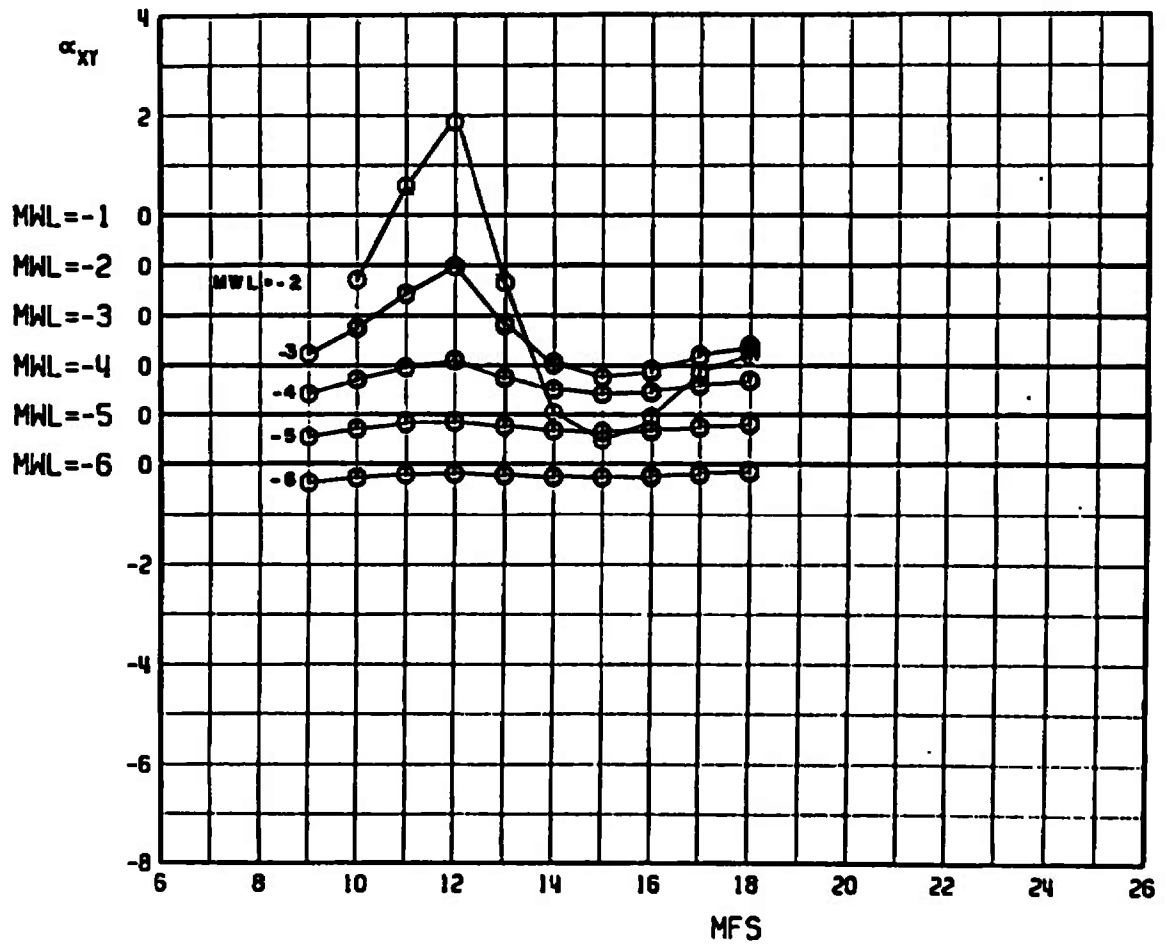


f. Sidewash, MBL 5
Fig. 17 Concluded

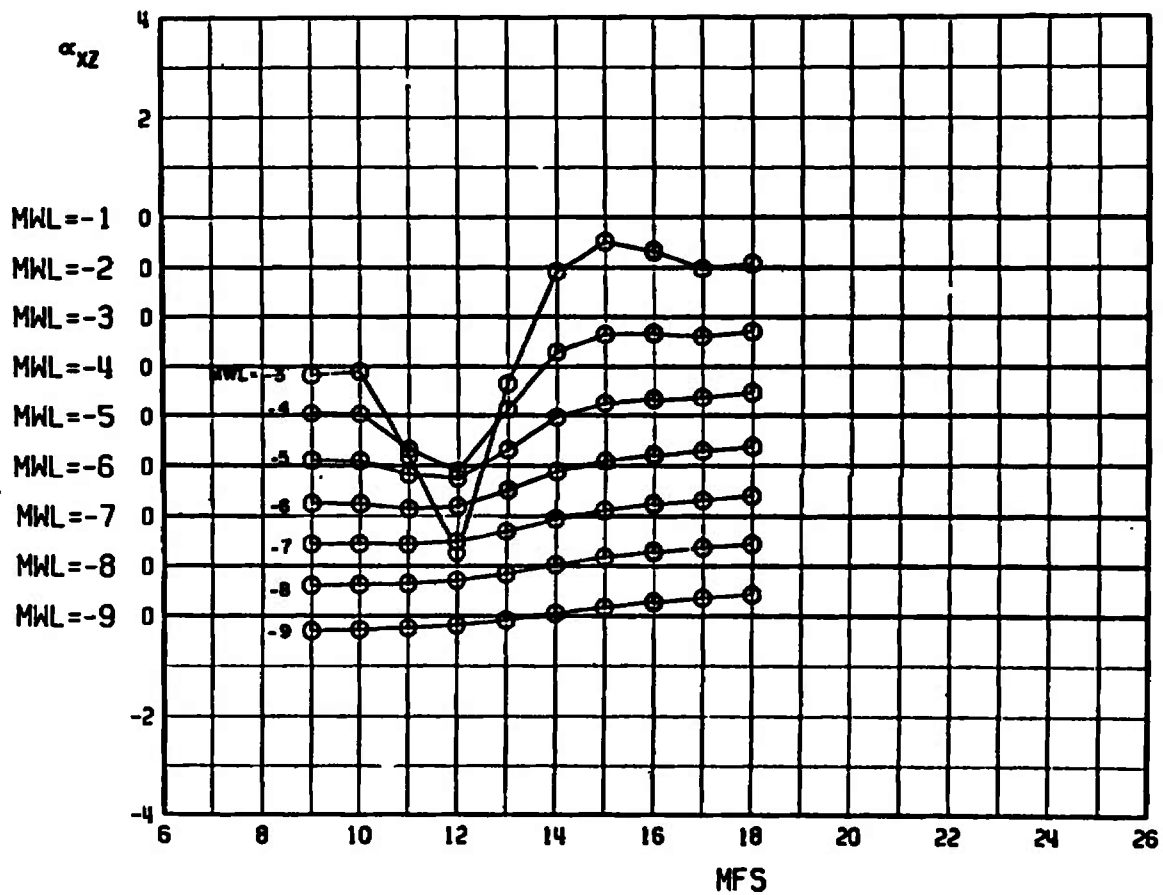


a. Upwash, MBL 3

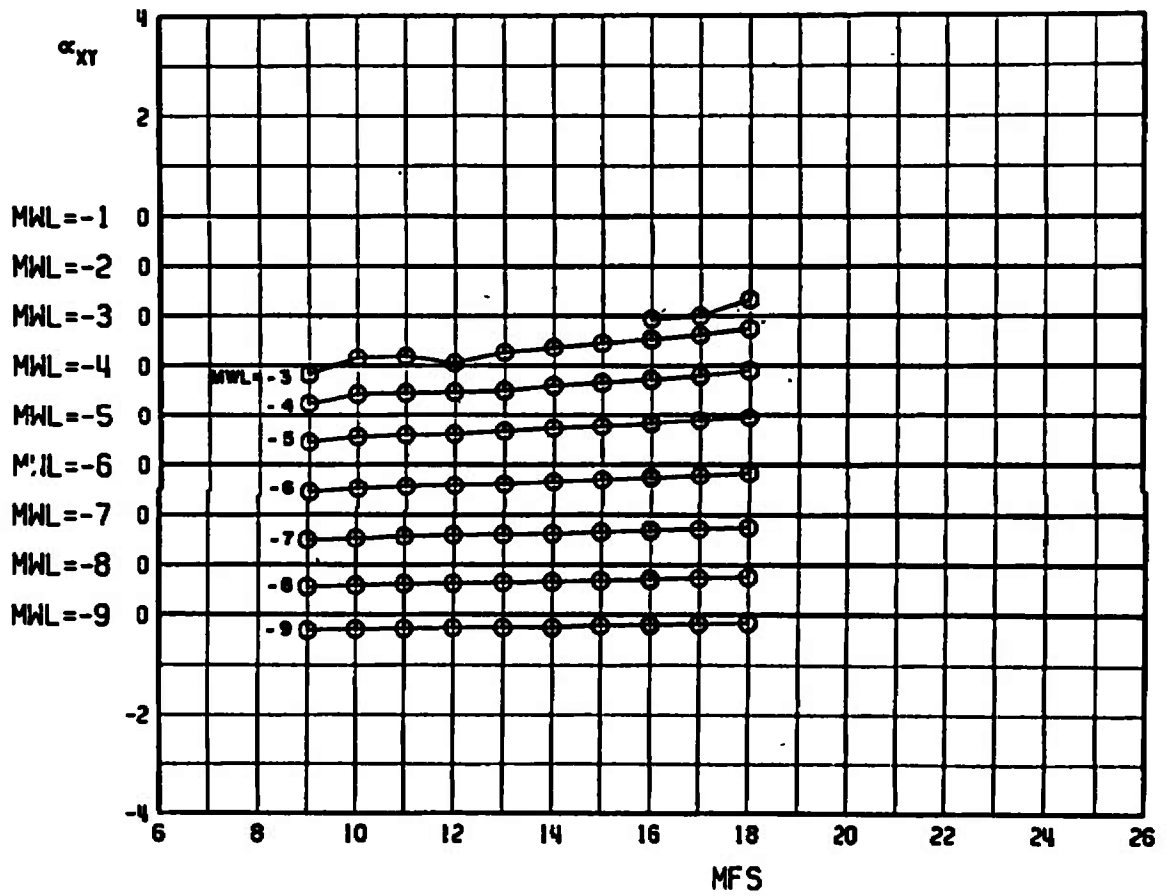
Fig. 18 Flow-Field Measurements beneath the Inboard Pylon, TER, and Two M-117 Stores at an Aircraft Angle of Attack of 0.3 deg, Configuration 5L



b. Sidewash, MBL 3
Fig. 18 Continued

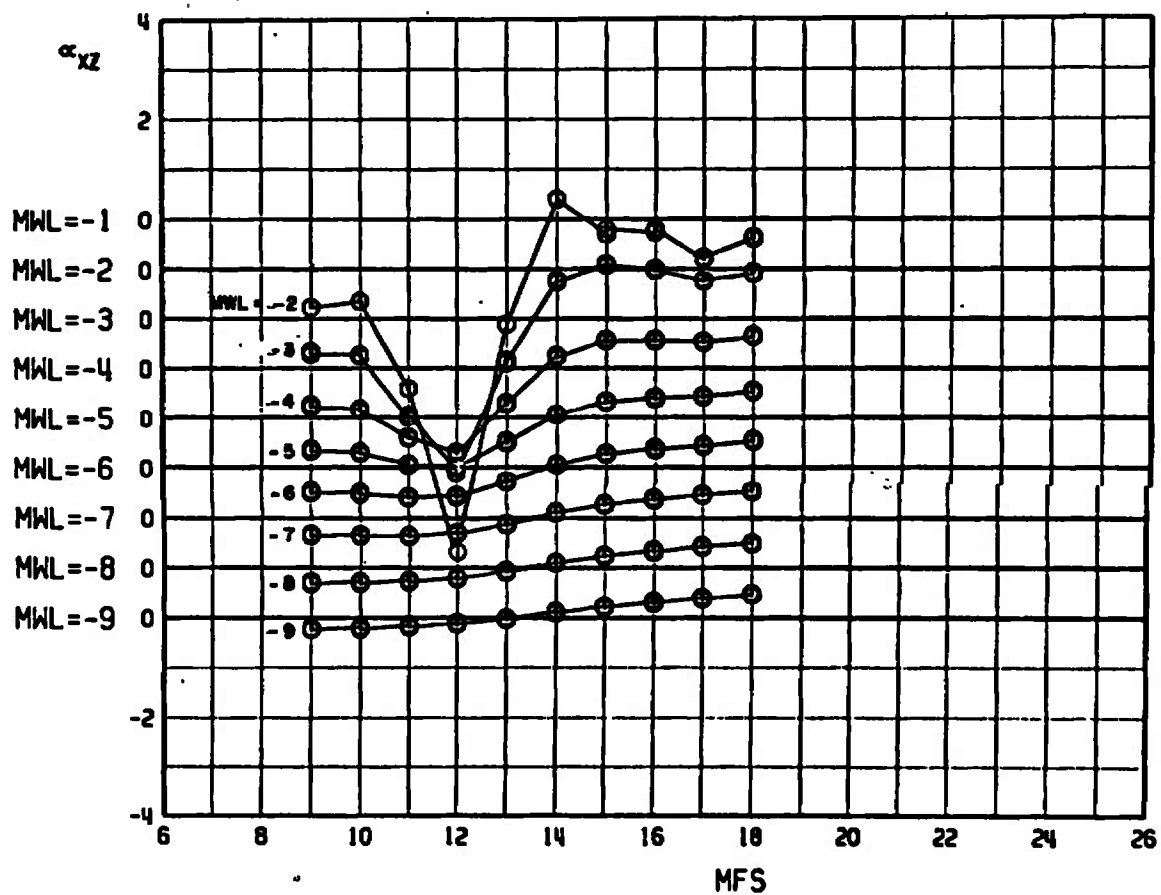


c. Upwash, MBL 4
Fig. 18 Continued

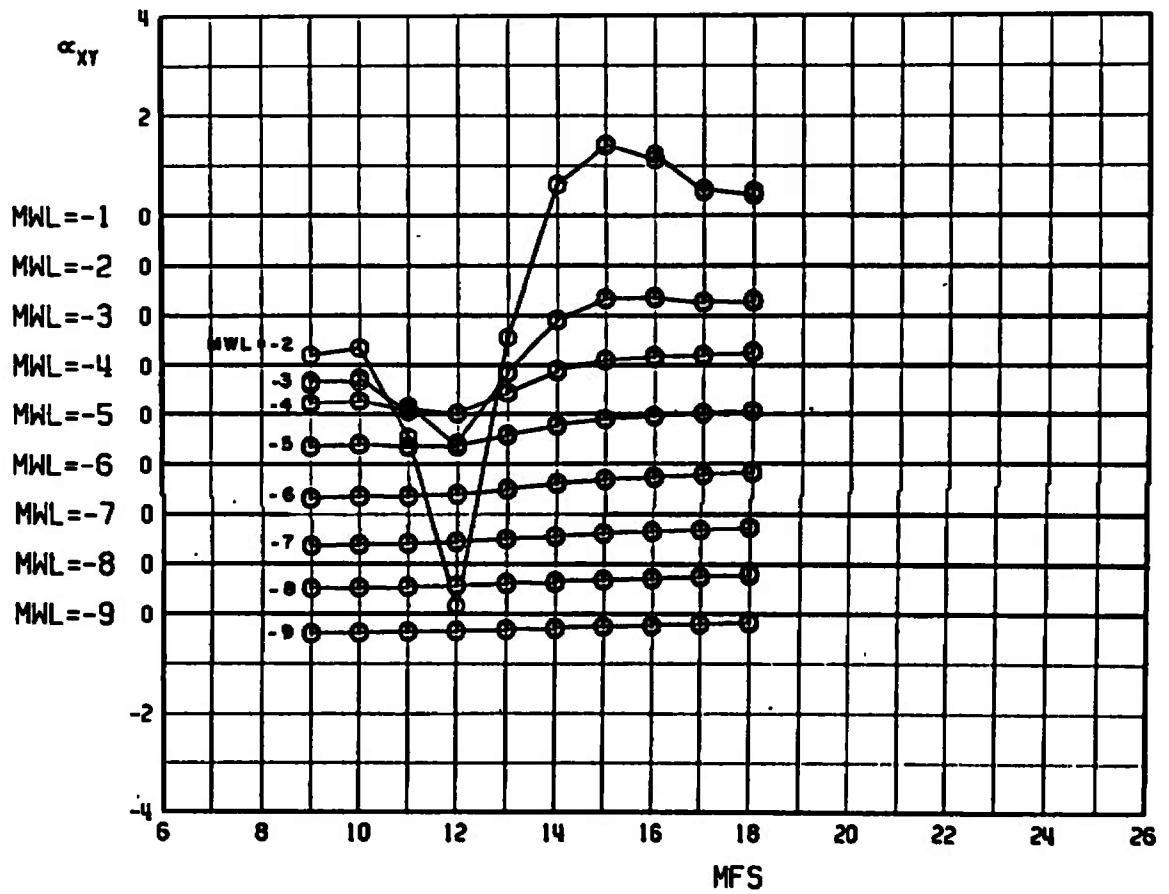


d. Sidewash, MBL 4

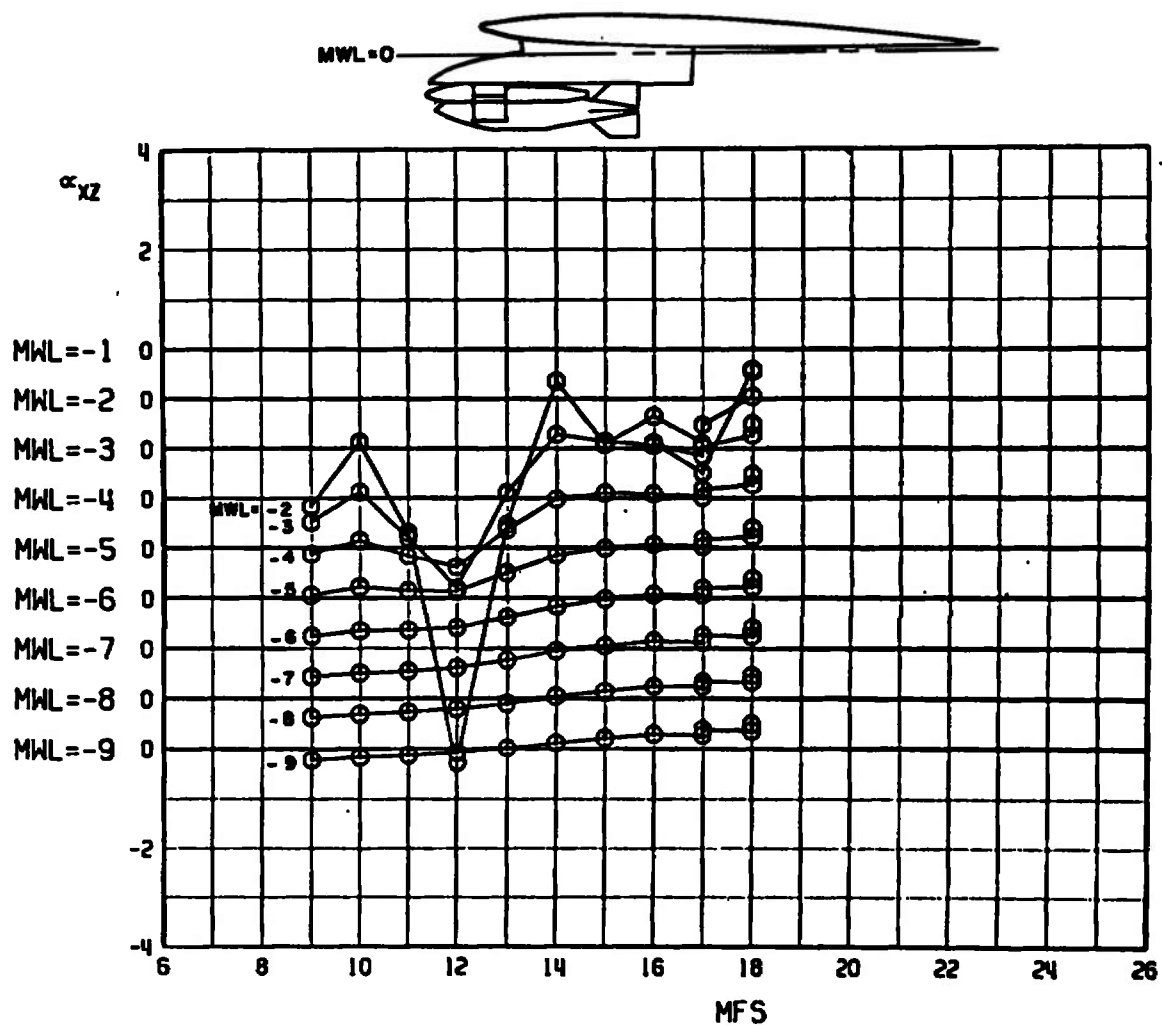
Fig. 18 Continued



e. Upwash, MBL 5
Fig. 18 Continued

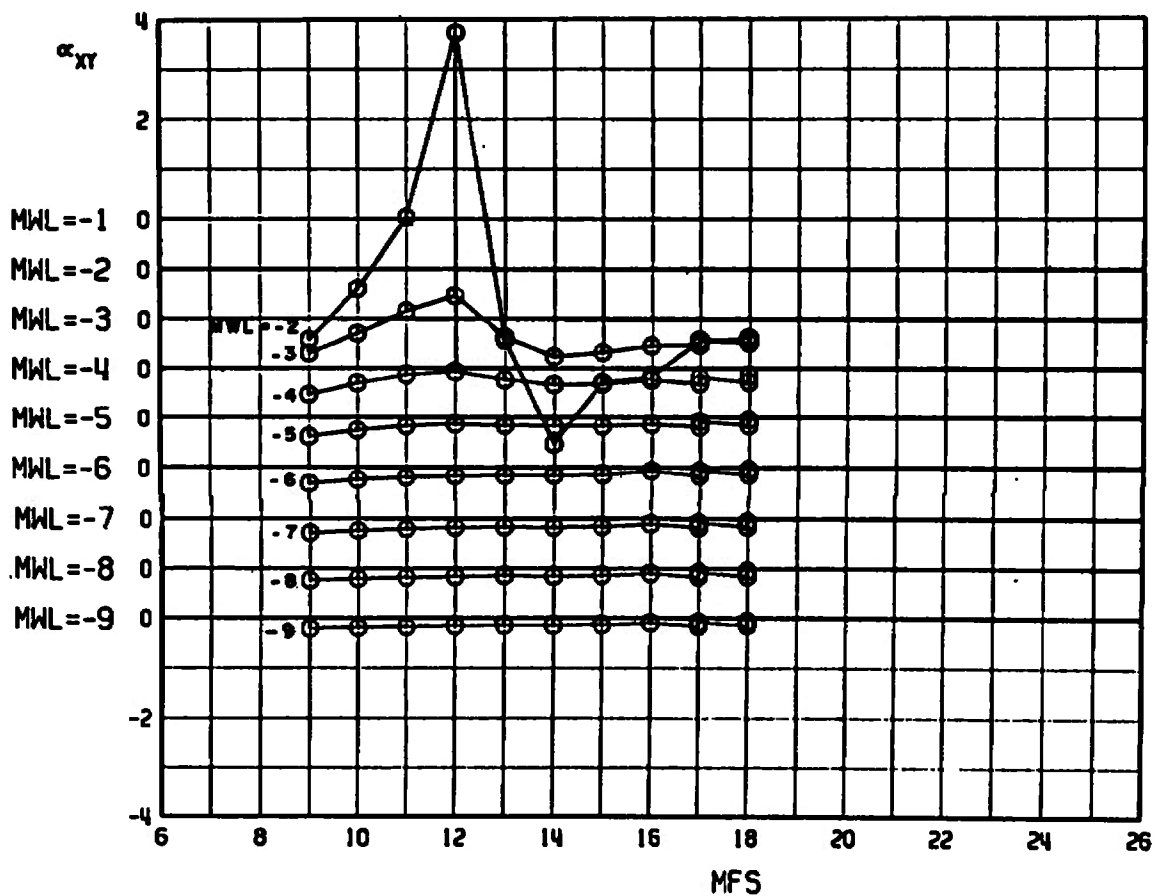


f. Sidewash, MBL 5
Fig. 18 Concluded

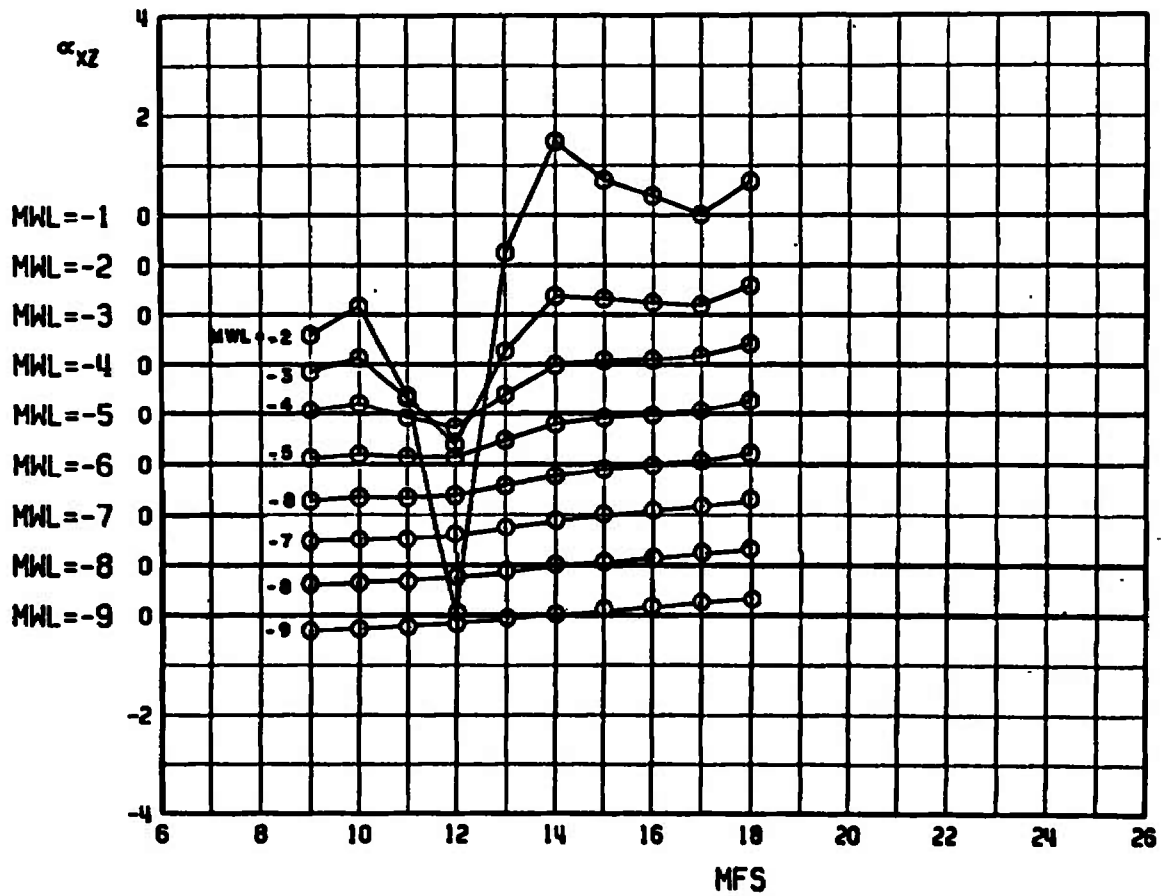


a. Upwash, MBL 3

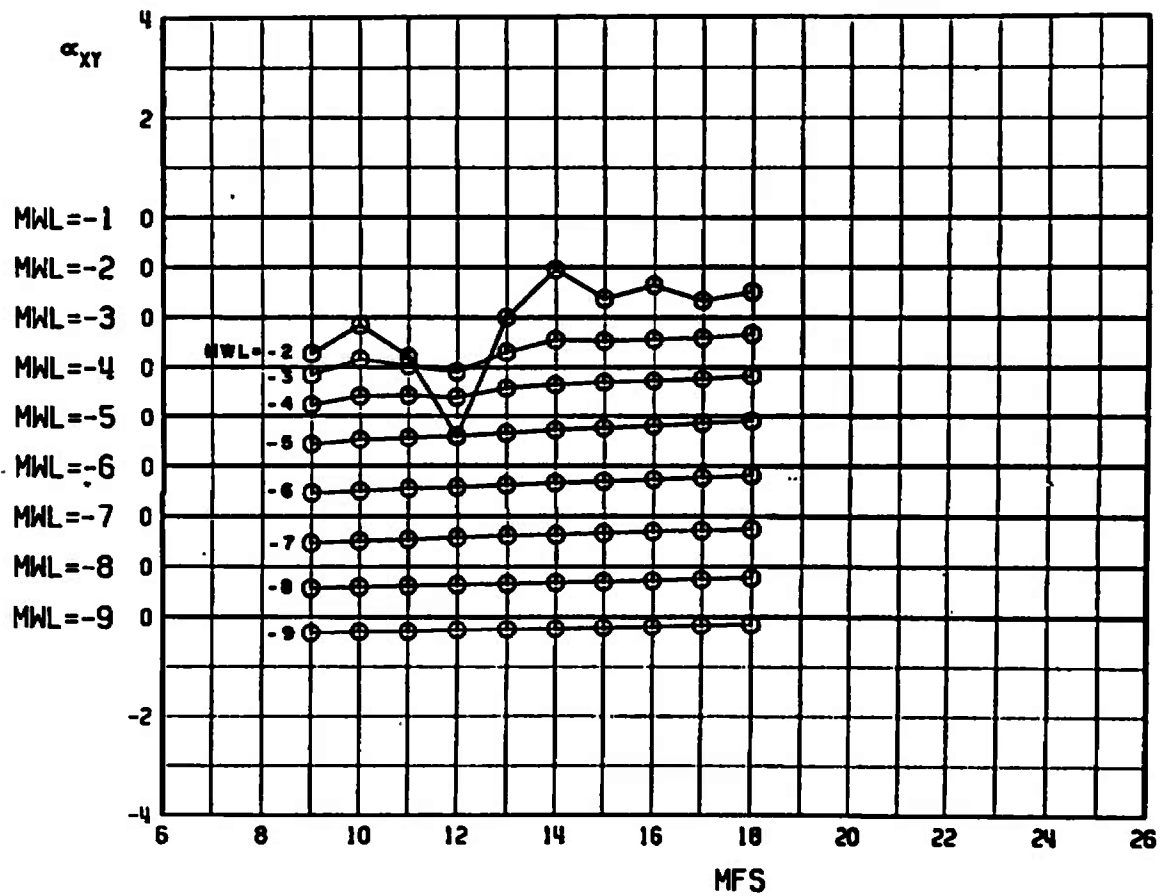
Fig. 19 Flow-Field Measurements beneath the Inboard Pylon, TER, and One M-117 Store at an Aircraft Angle of 0.3 deg, Configuration 6L



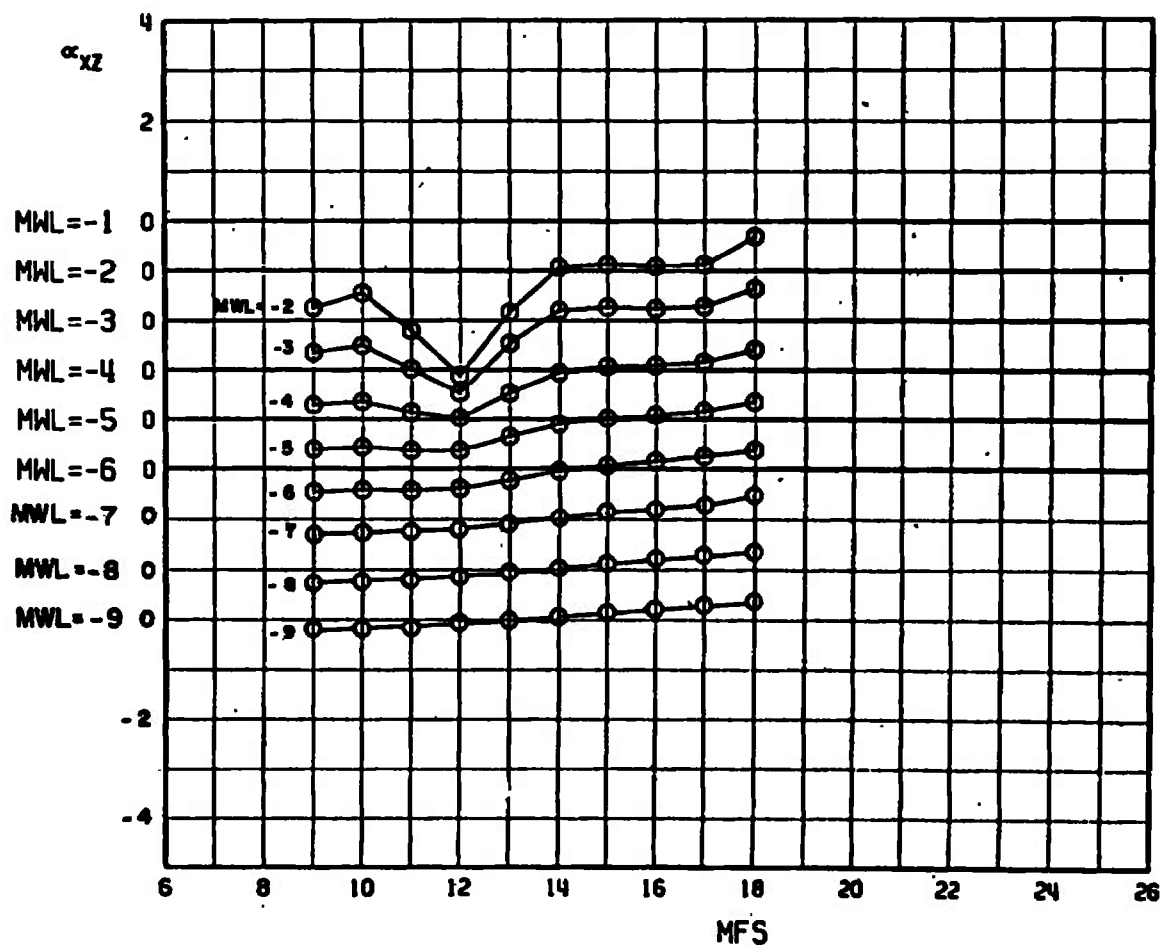
b. Sidewash, MBL 3
Fig. 19 Continued



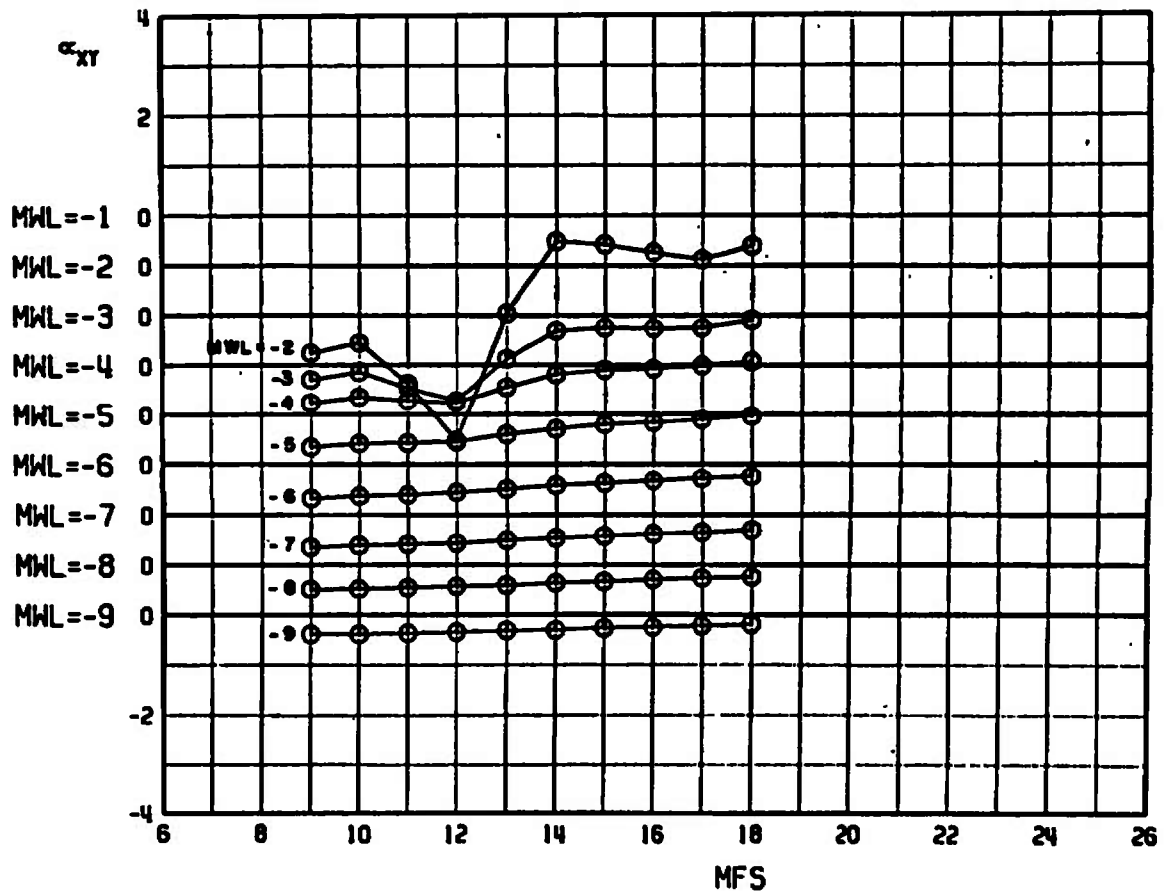
c. Upwash, MBL 4
Fig. 19 Continued



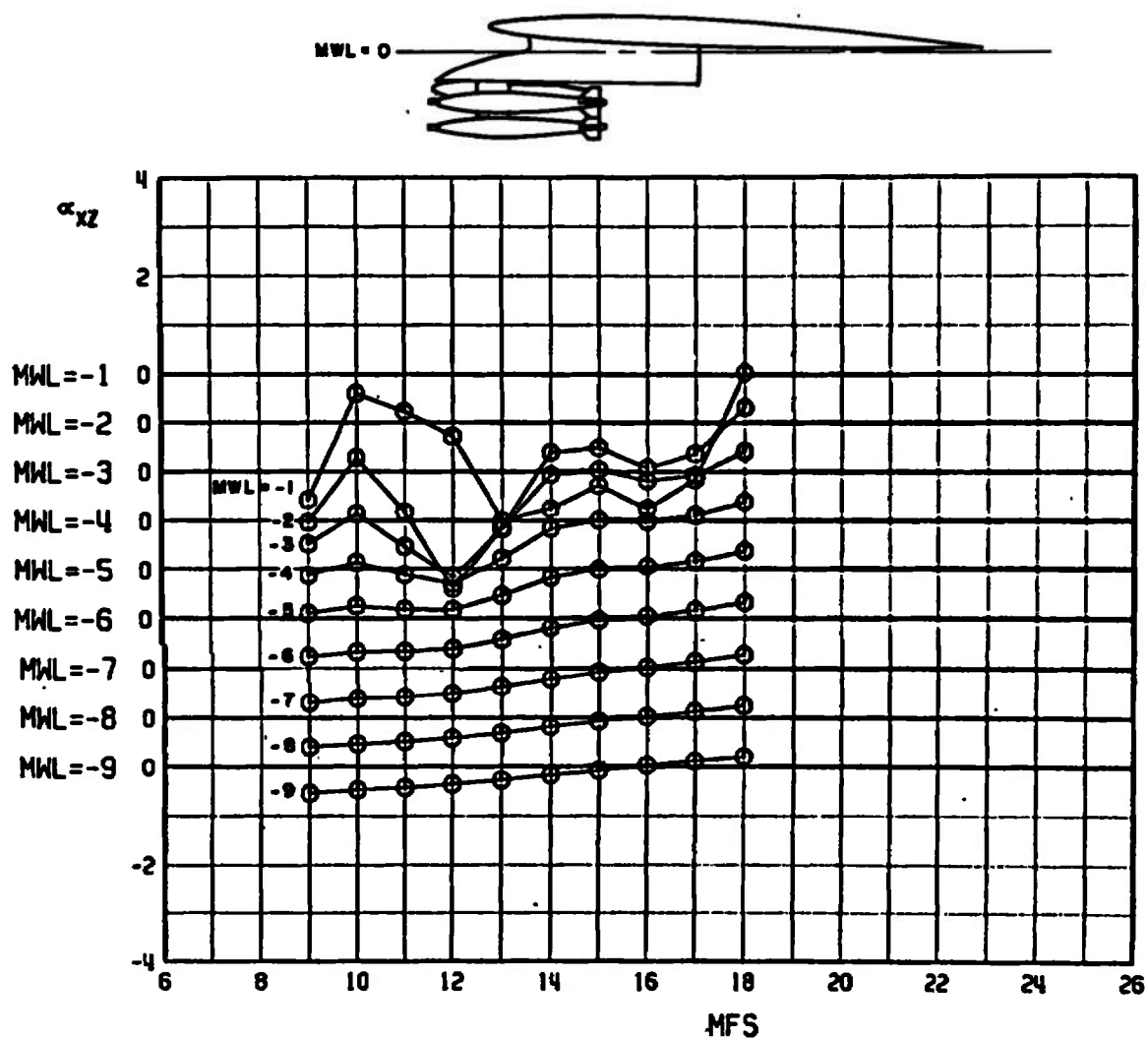
d. Sidewash, MBL 4
Fig. 19 Continued



a. Upwash, MBL 5
Fig. 19 Continued

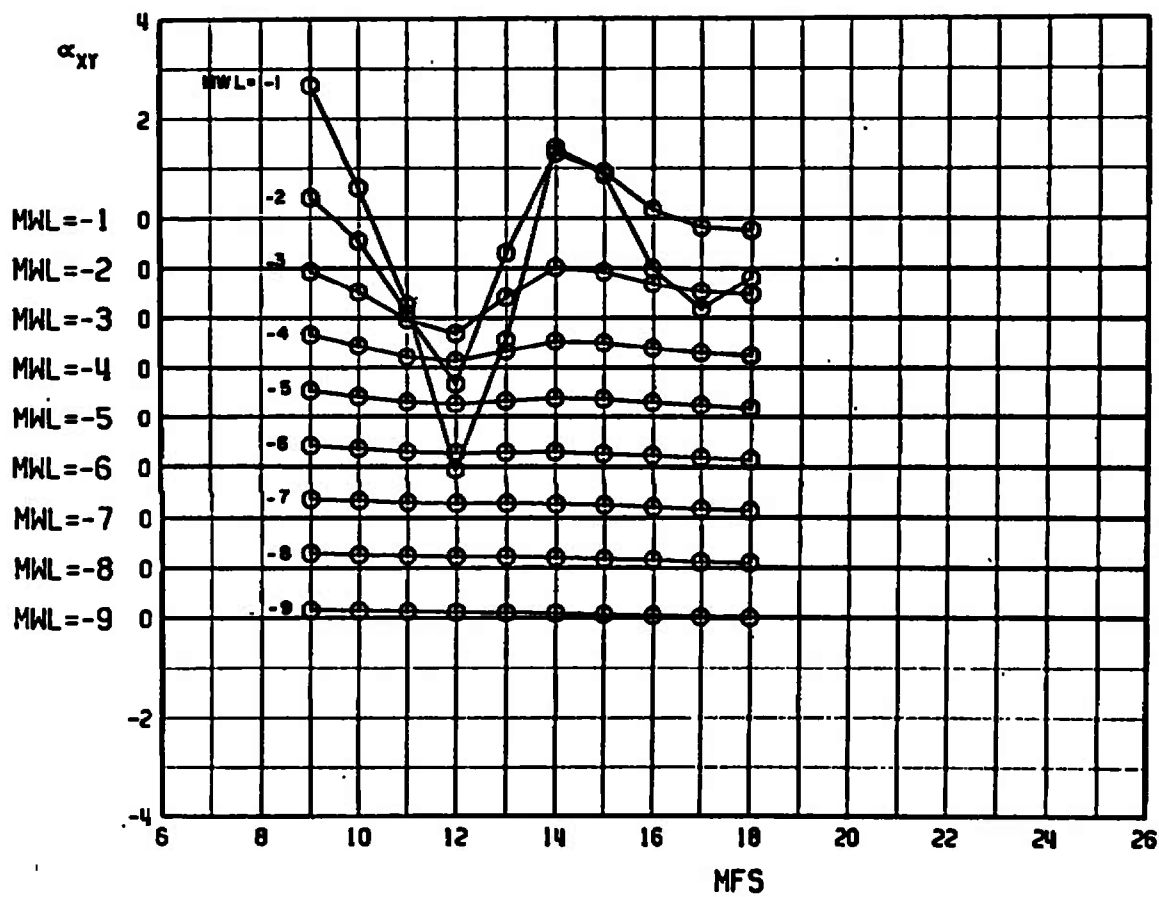


f. Sidewash, MBL 5
Fig. 19 Concluded

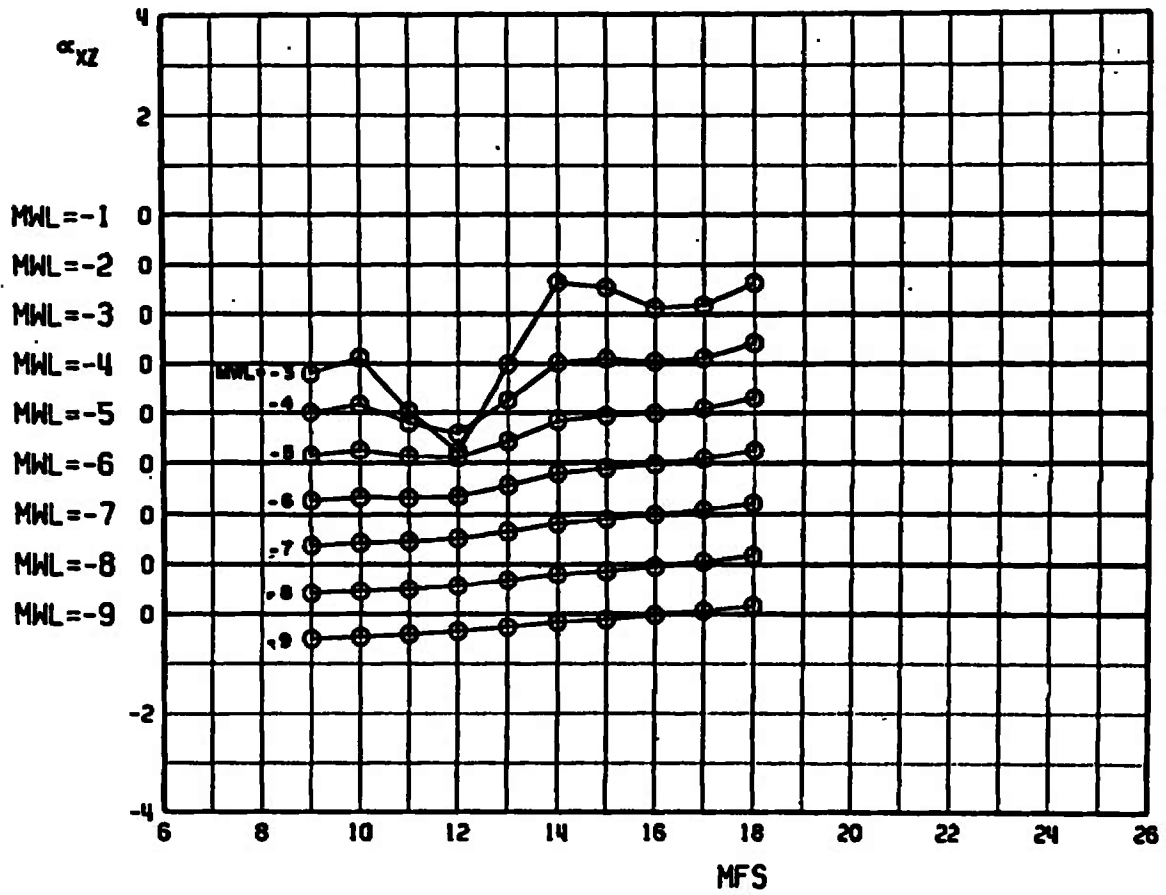


a. Upwash, MBL 3

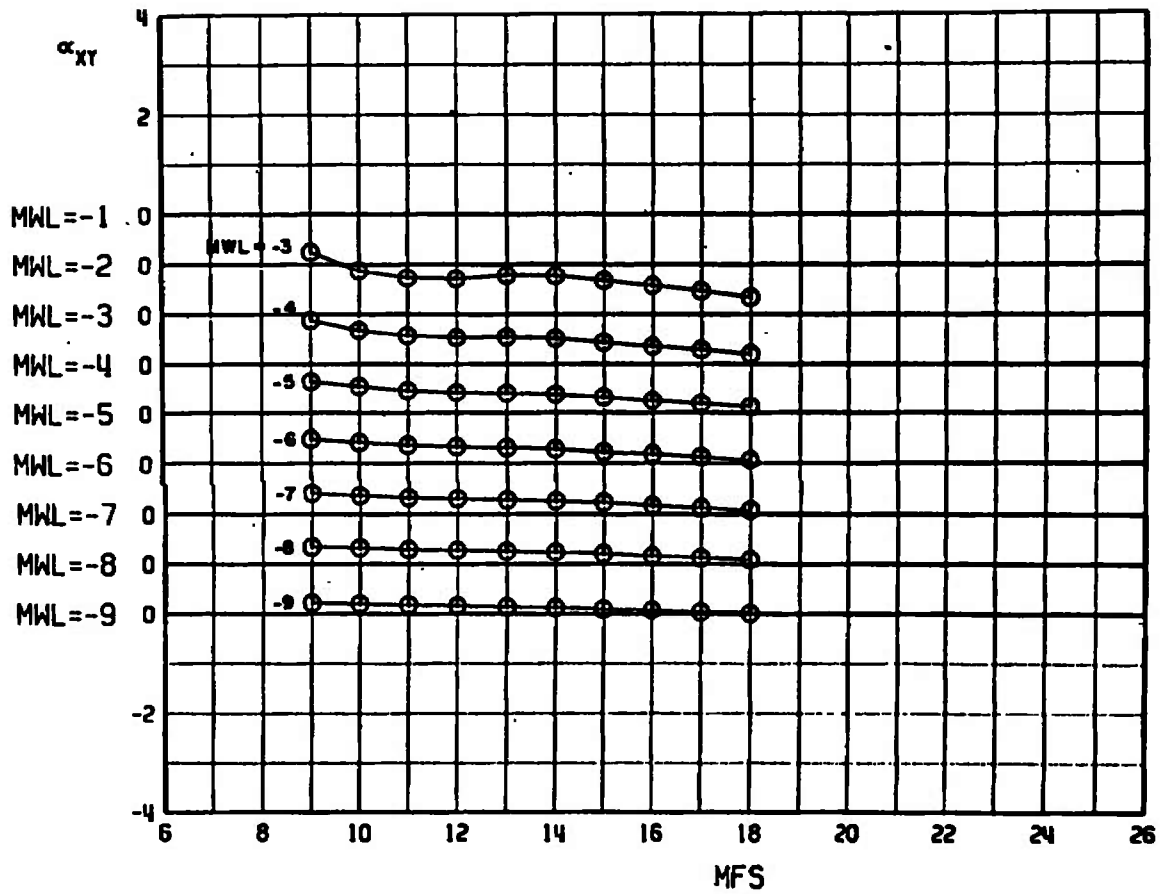
Fig. 20 Flow-Field Measurements beneath the Inboard Pylon, TER, and Three MK-81 Stores at an Aircraft Angle of Attack of 0.30 deg, Configuration 7R



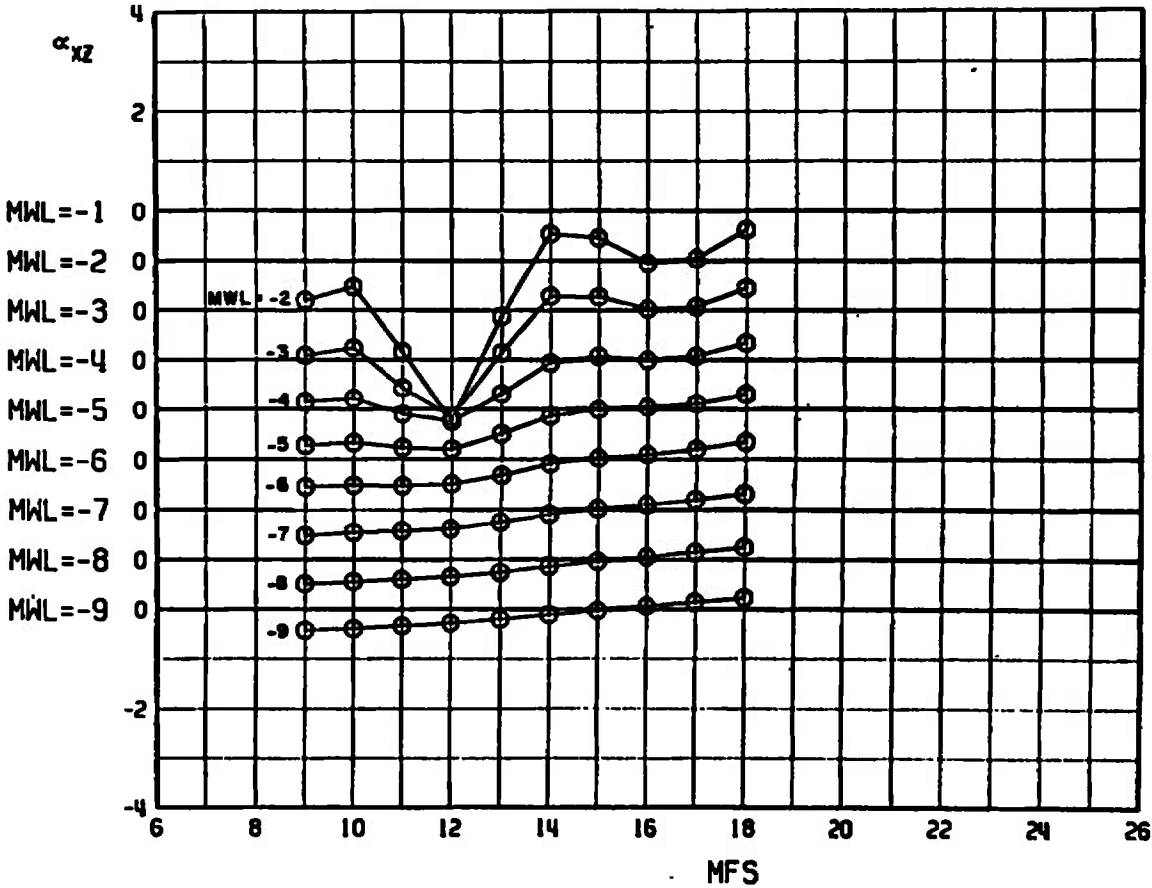
b. Sidewash, MBL 3
Fig. 20 Continued



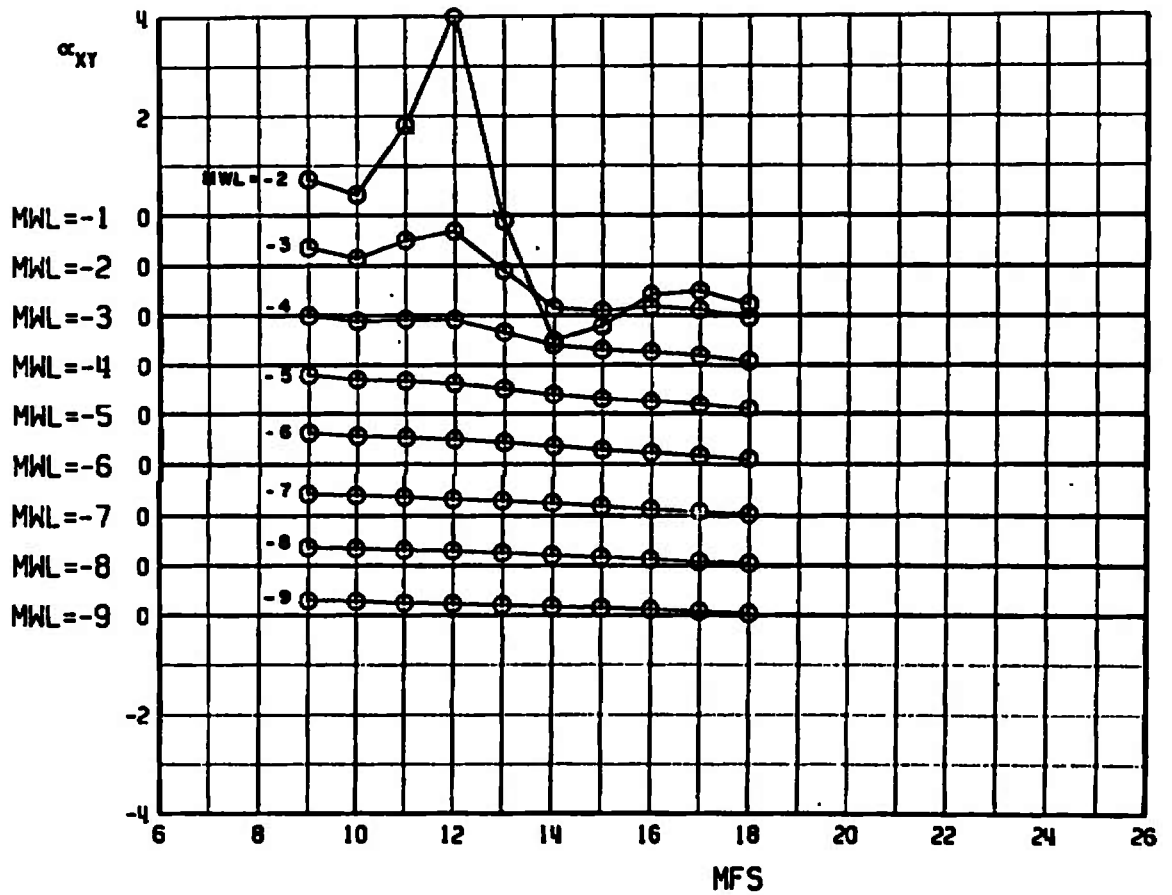
c. Upwash, MBL 4
Fig. 20 Continued



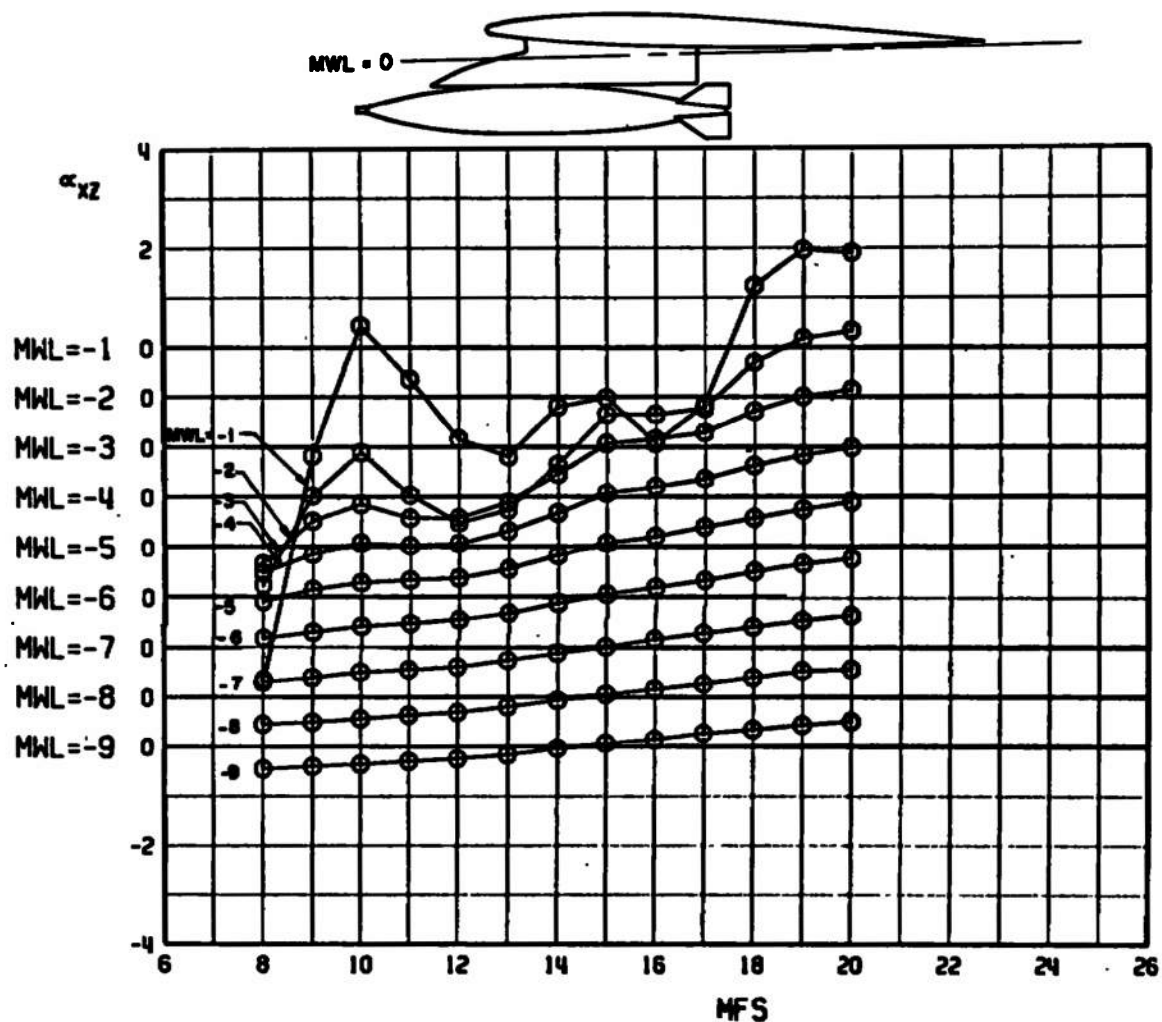
d. Sidewash, MBL 4
Fig. 20 Continued



e. Upwash, MBL 5
Fig. 20 Continued

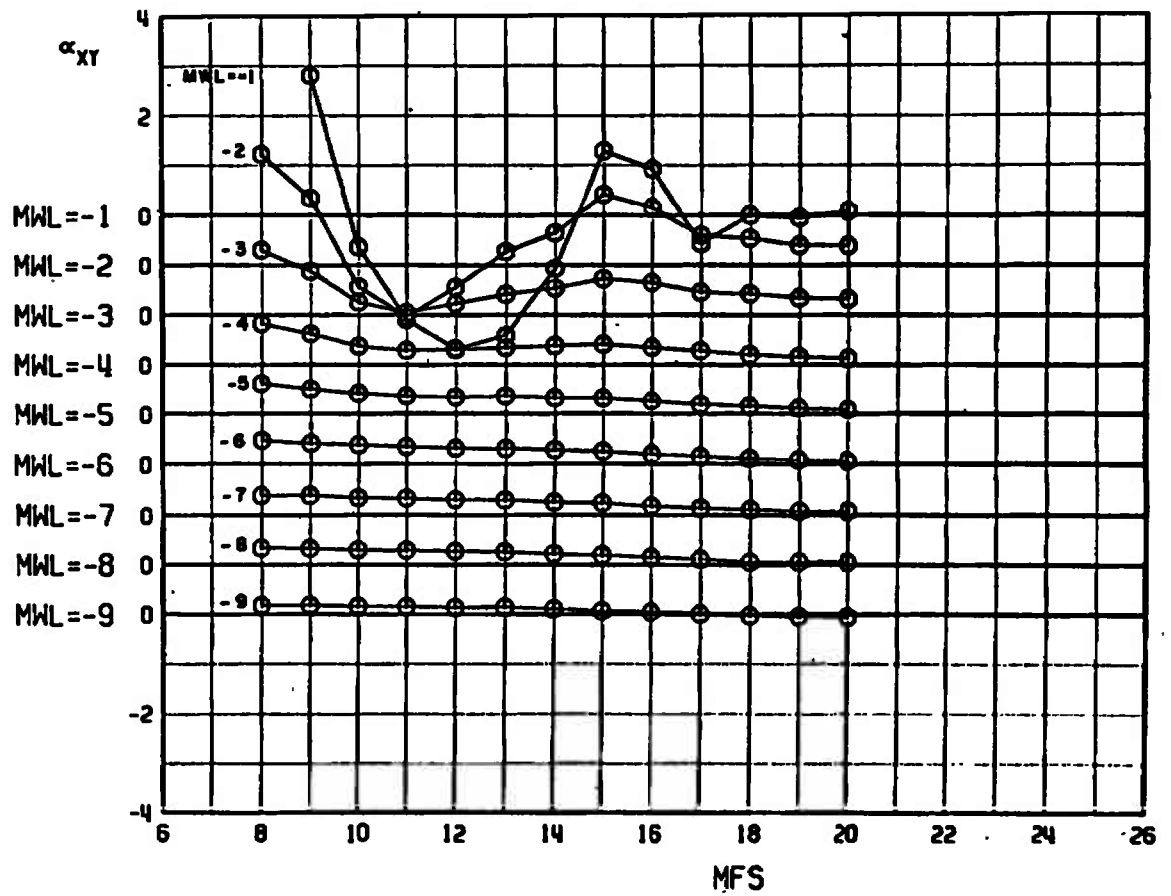


f. Sidewash, MBL 5
Fig. 20 Concluded

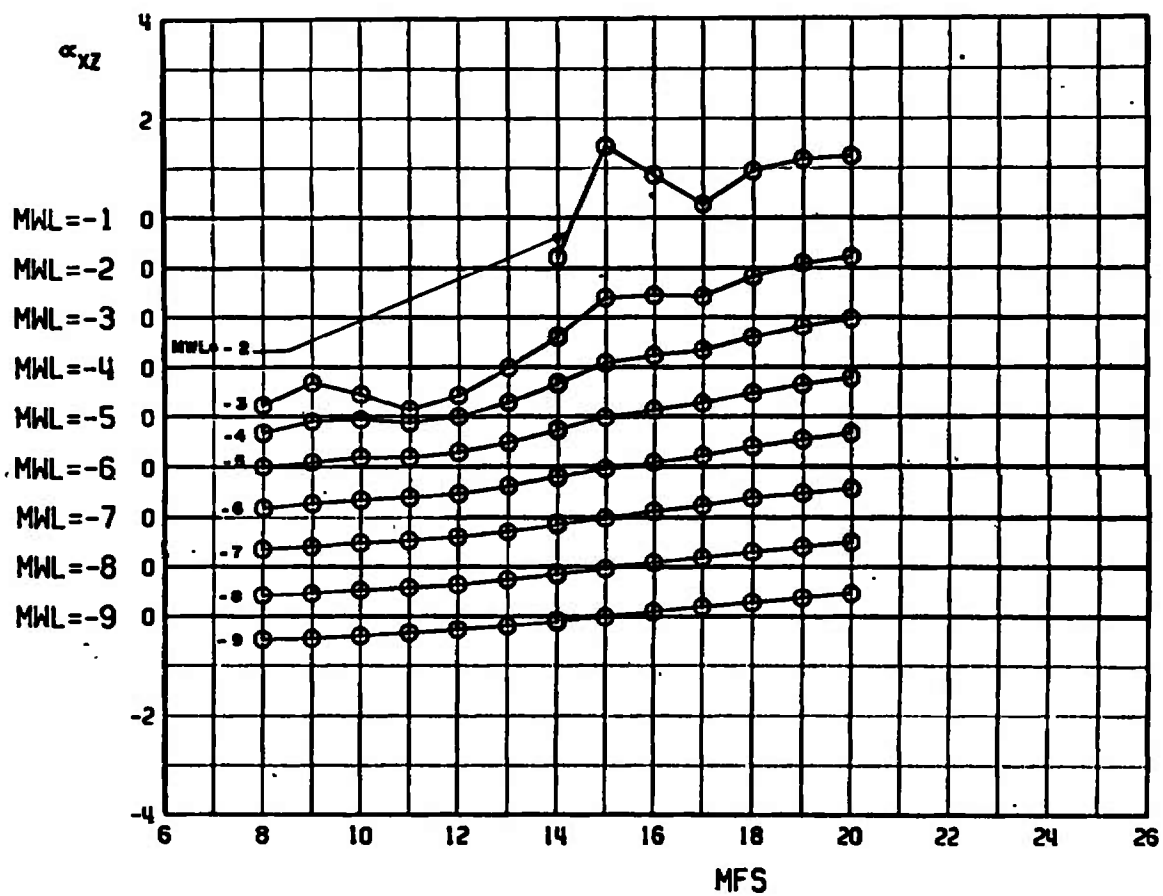


a. Upwash, MBL 3

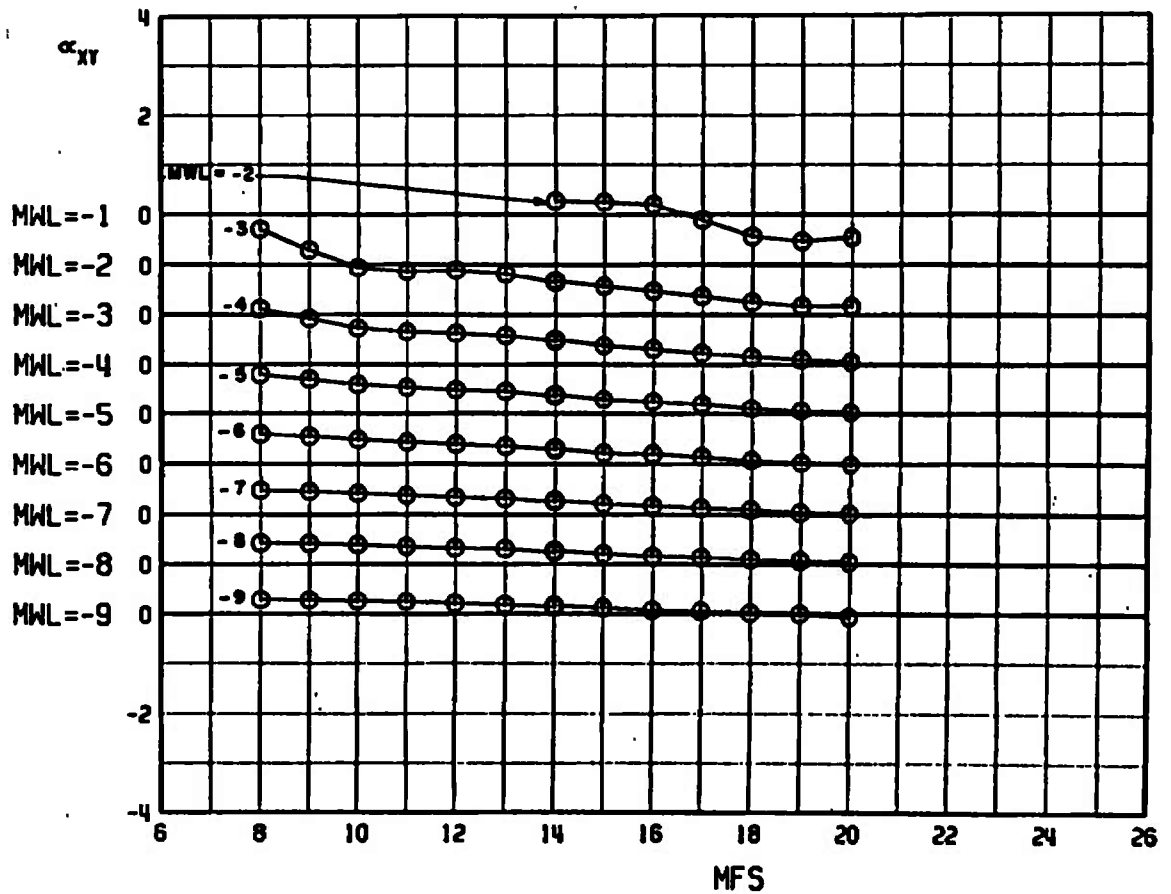
Fig. 21 Flow-Field Measurements beneath the Inboard Pylon and MK-84 Store at an Aircraft Angle of Attack of 0.30 deg, Configuration 8R



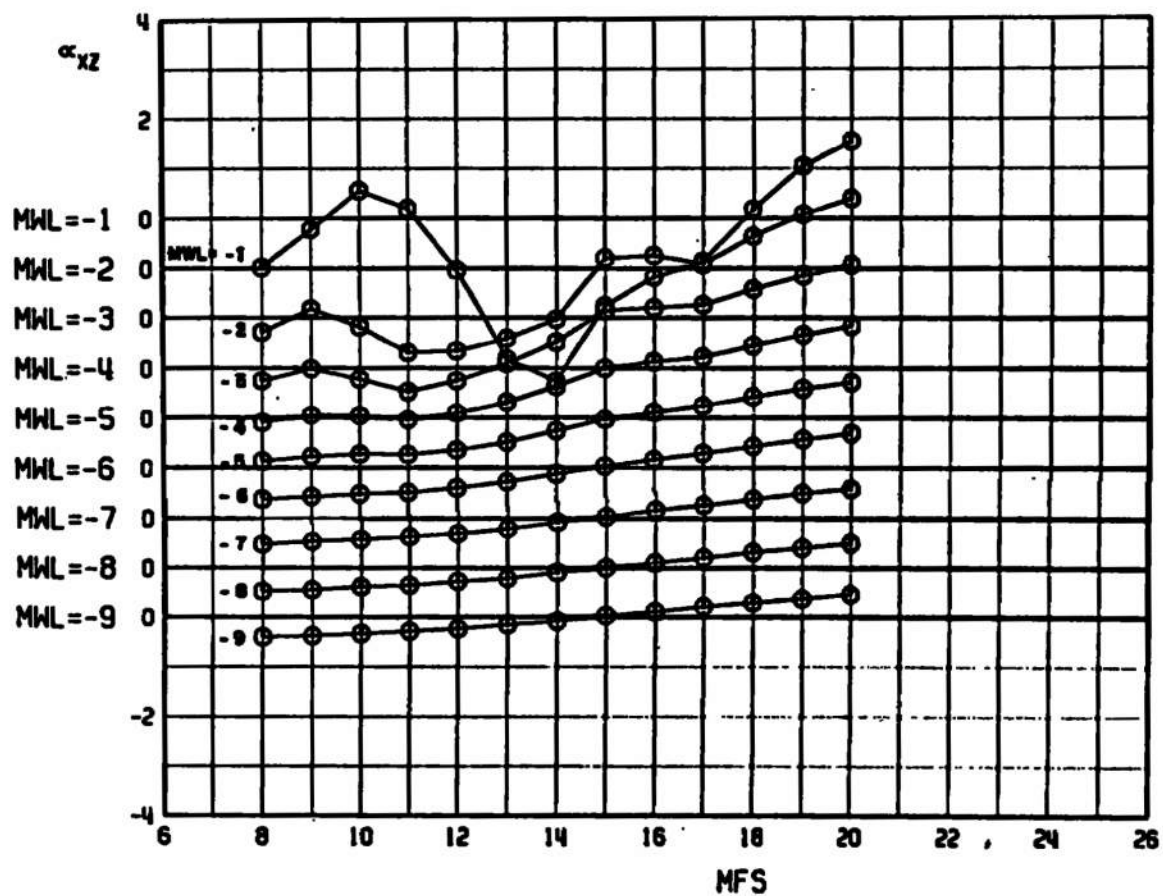
b. Sidewash, MBL 3
Fig. 21 Continued



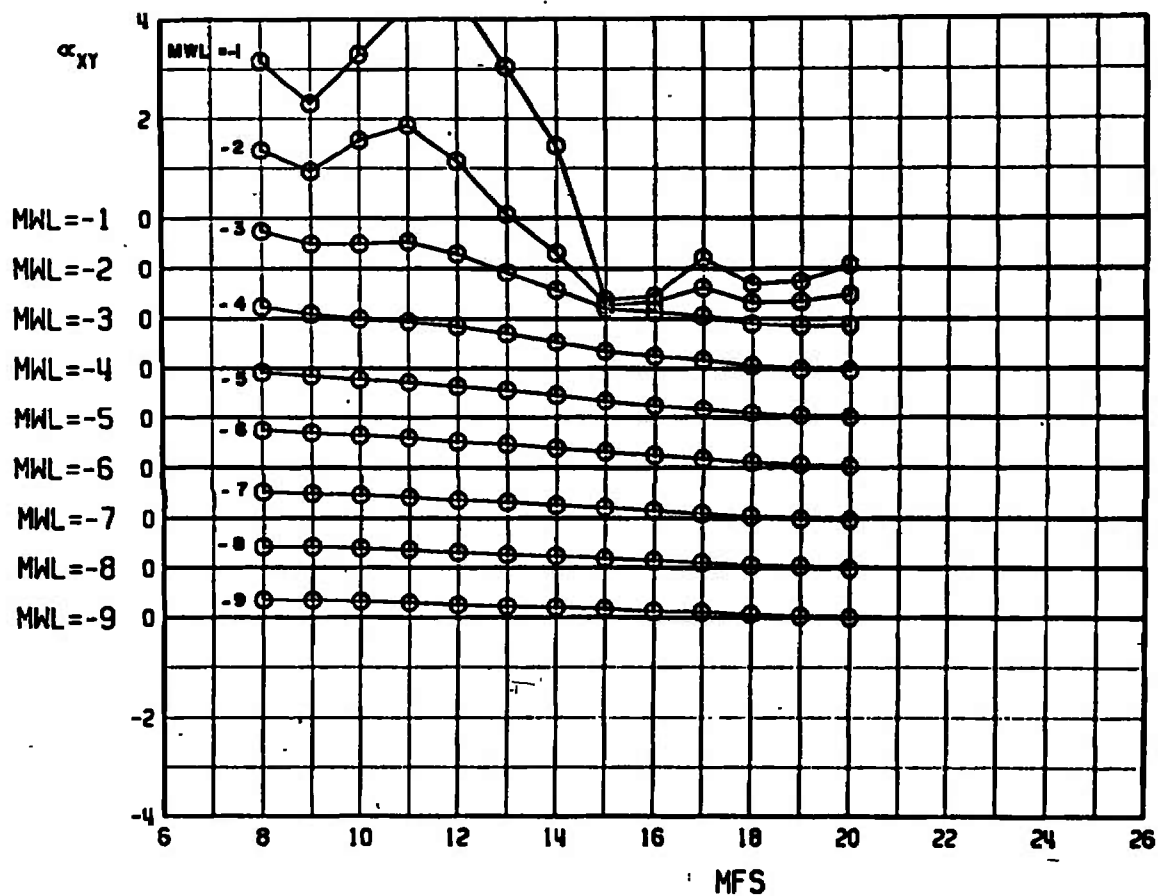
c. Upwash, MBL 4
Fig. 21 Continued



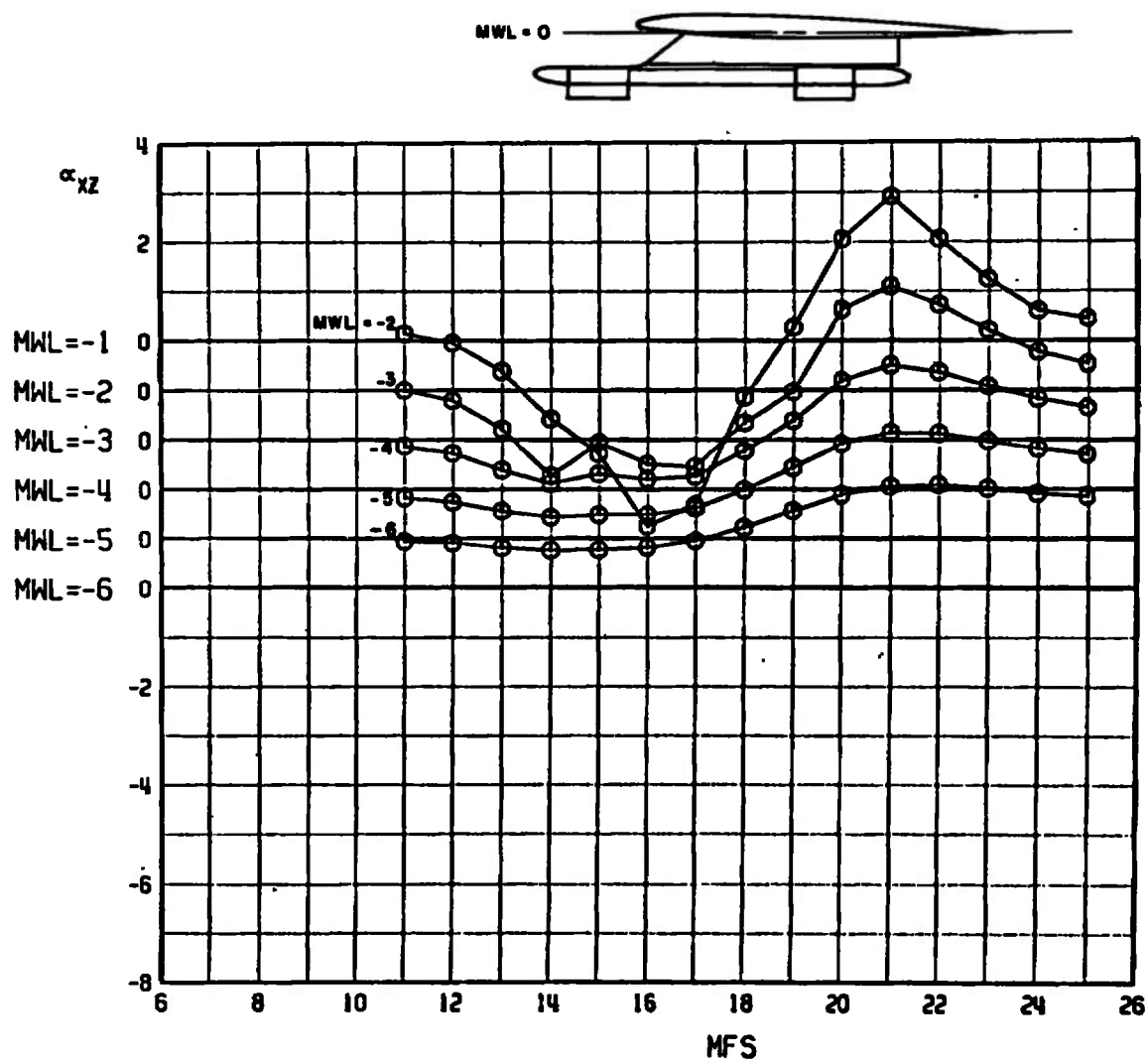
d. Sidewash, MBL 4
Fig. 21 Continued



e. Upwash, MBL 5
Fig. 21 Continued

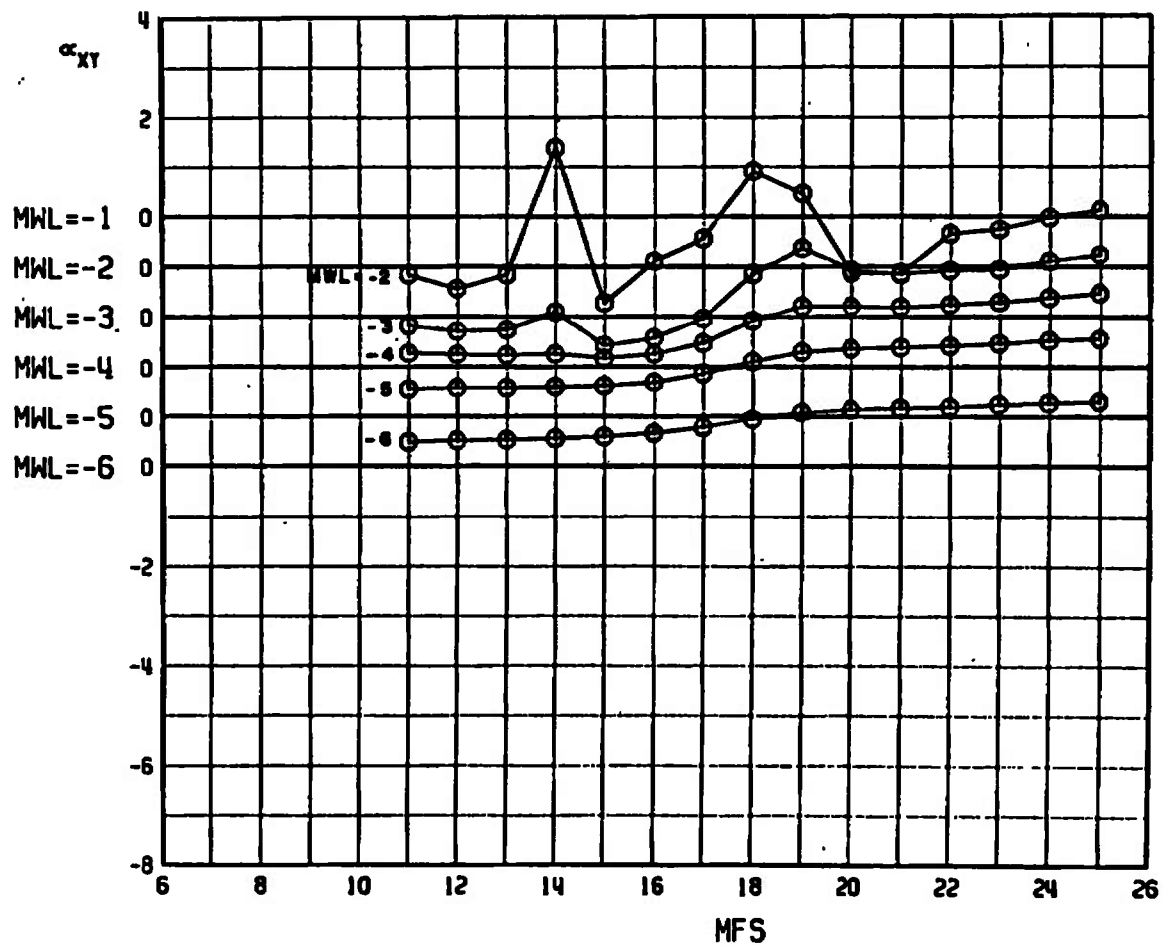


f. Sidewash, MBL 5
Fig. 21 Concluded

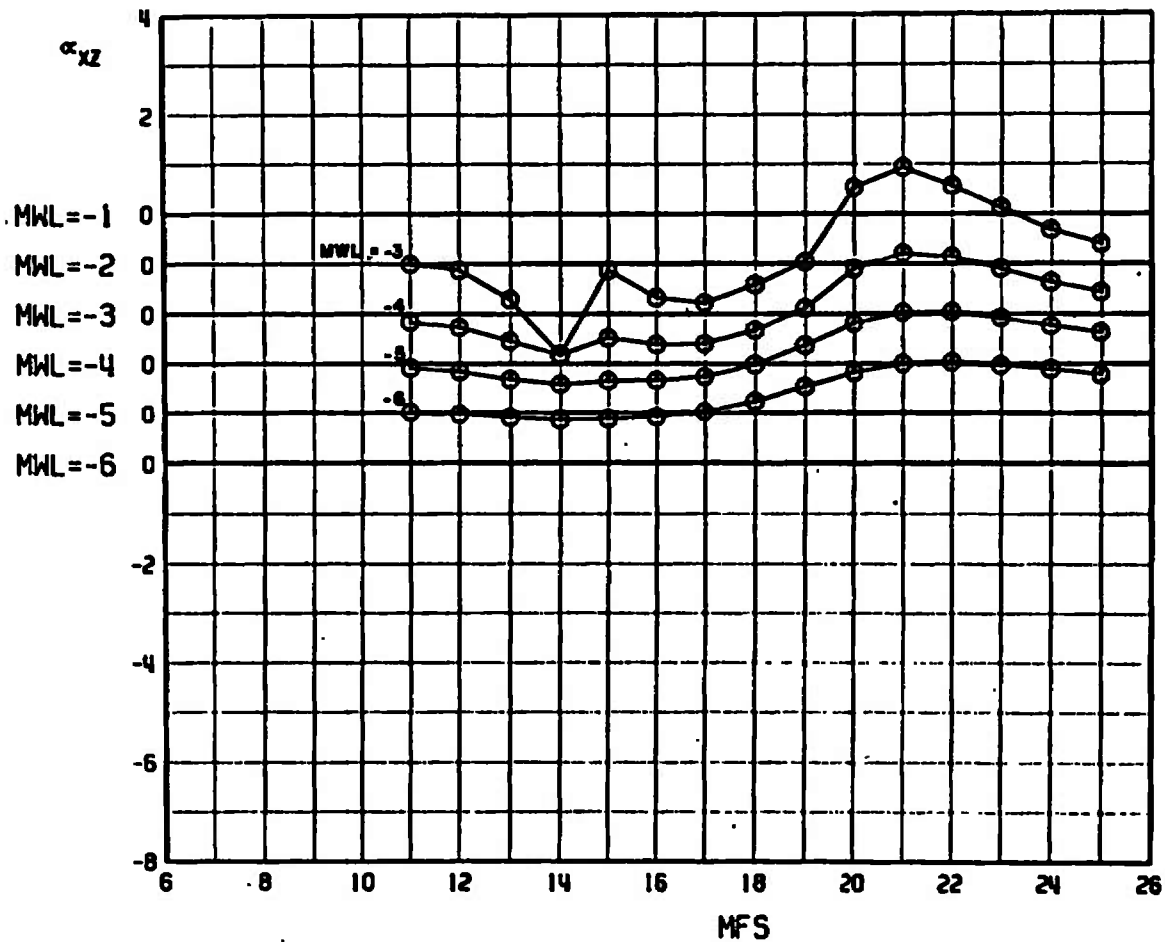


a. Upwash, MBL 6

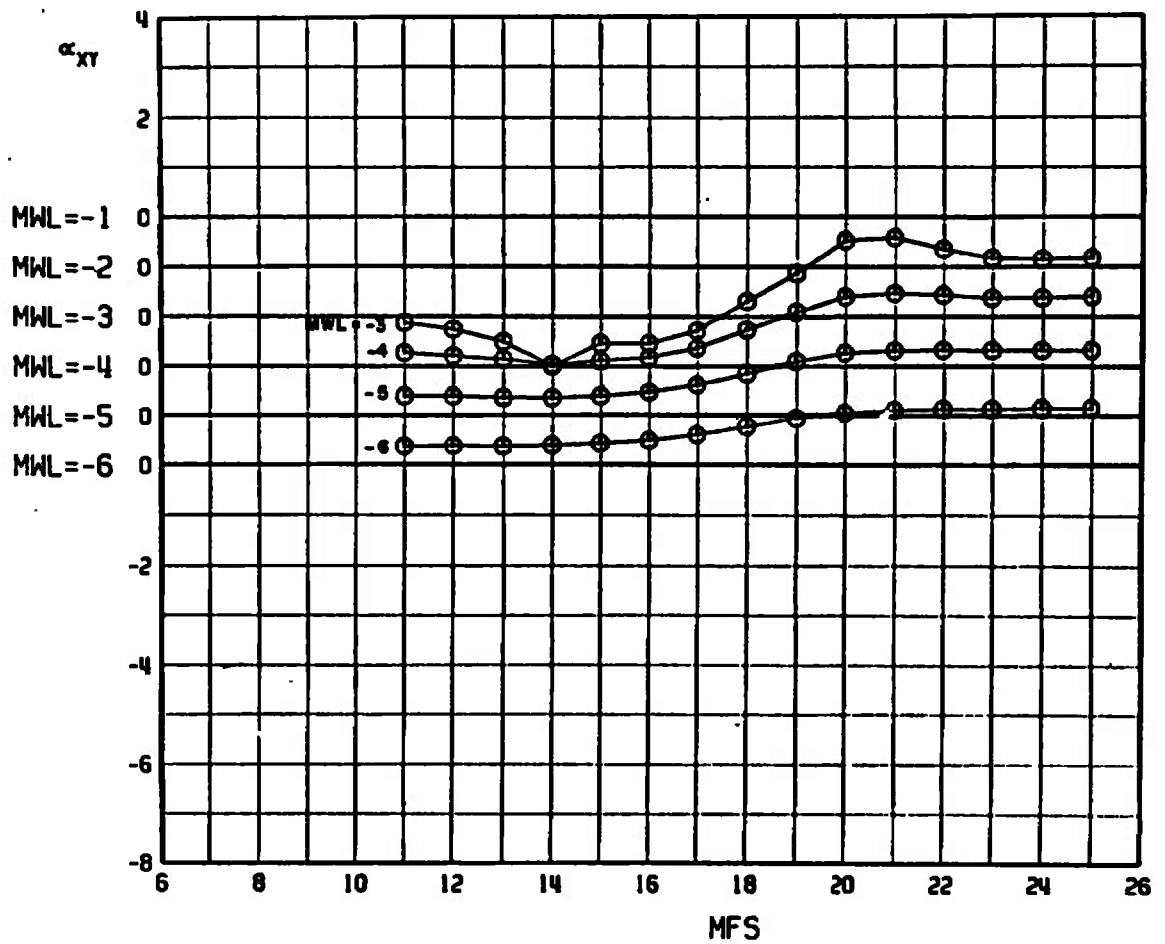
Fig. 22 Flow-Field Measurements beneath the Outboard Pylon and MER at an Aircraft Angle of Attack of 0.30 deg, Configuration 9L



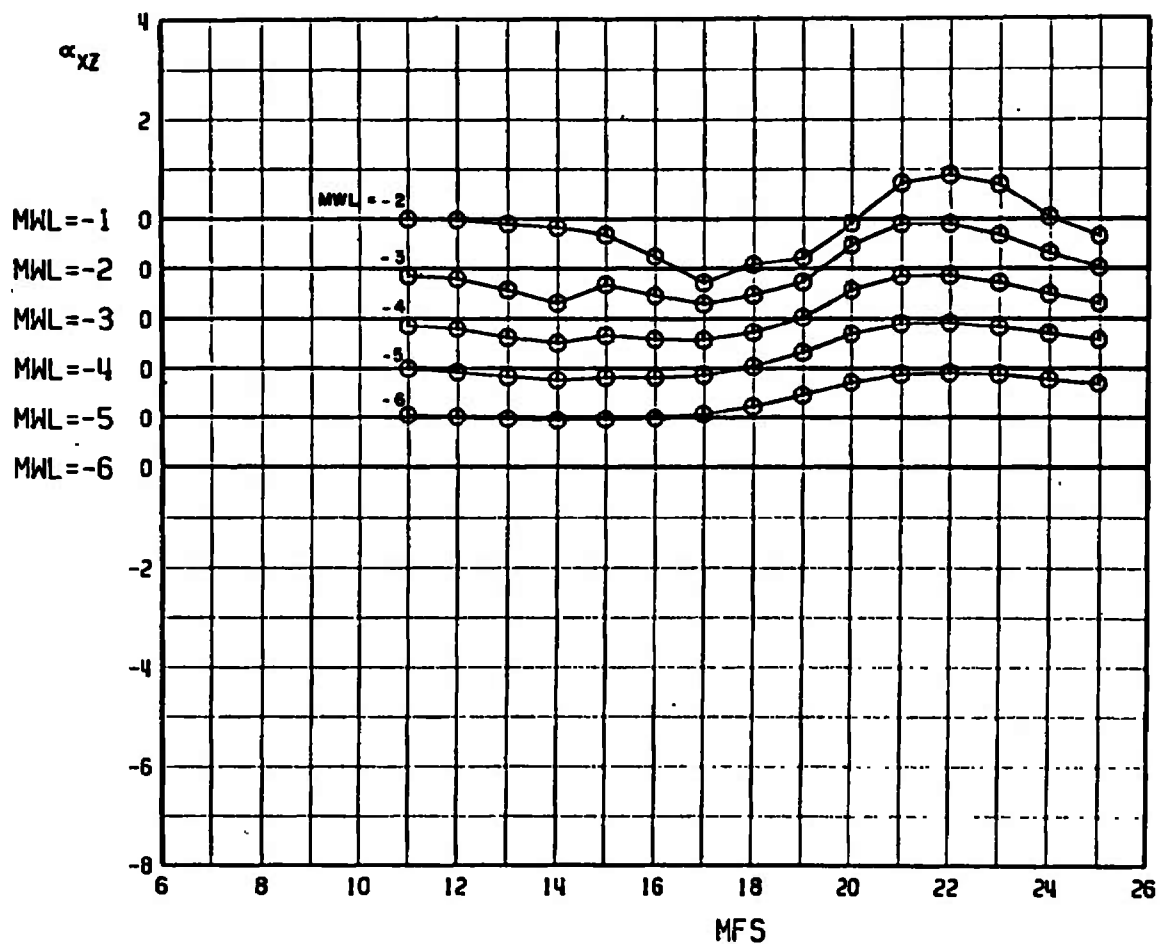
b. Sidewash, MBL 6
Fig. 22 Continued



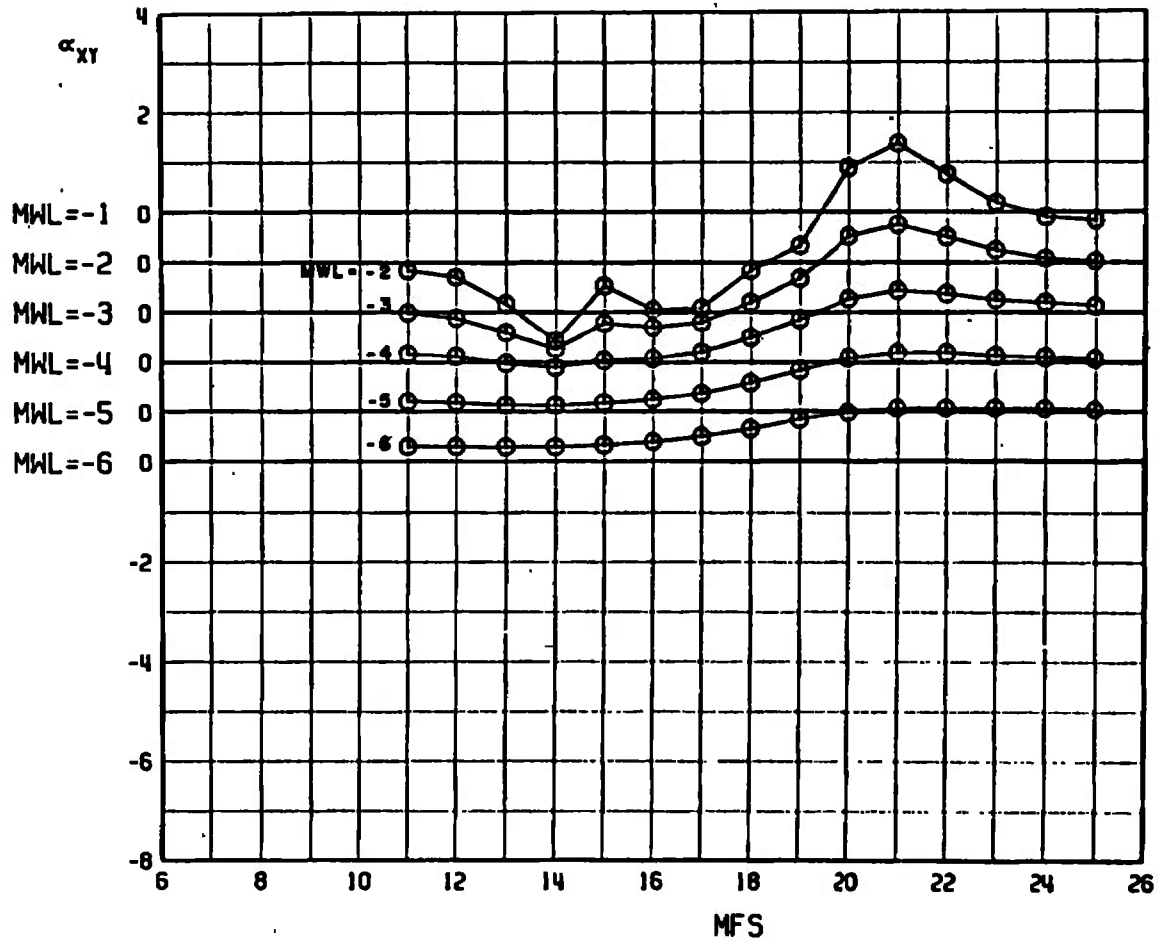
c. Upwash, MBL 7
Fig. 22 Continued



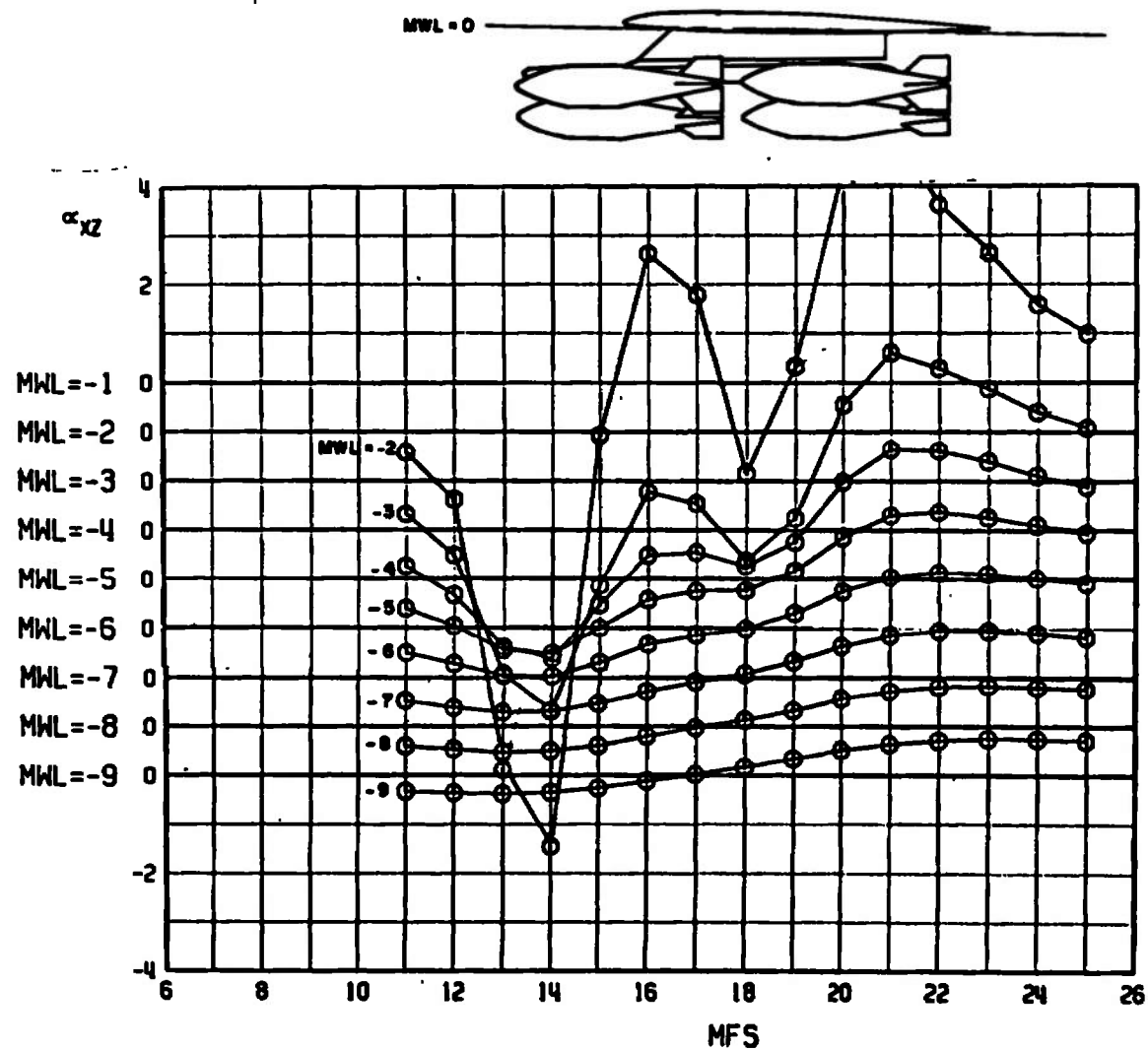
d. Sidewash, MBL 7
Fig. 22 Continued



e. Upwash, MBL 8
Fig. 22 Continued

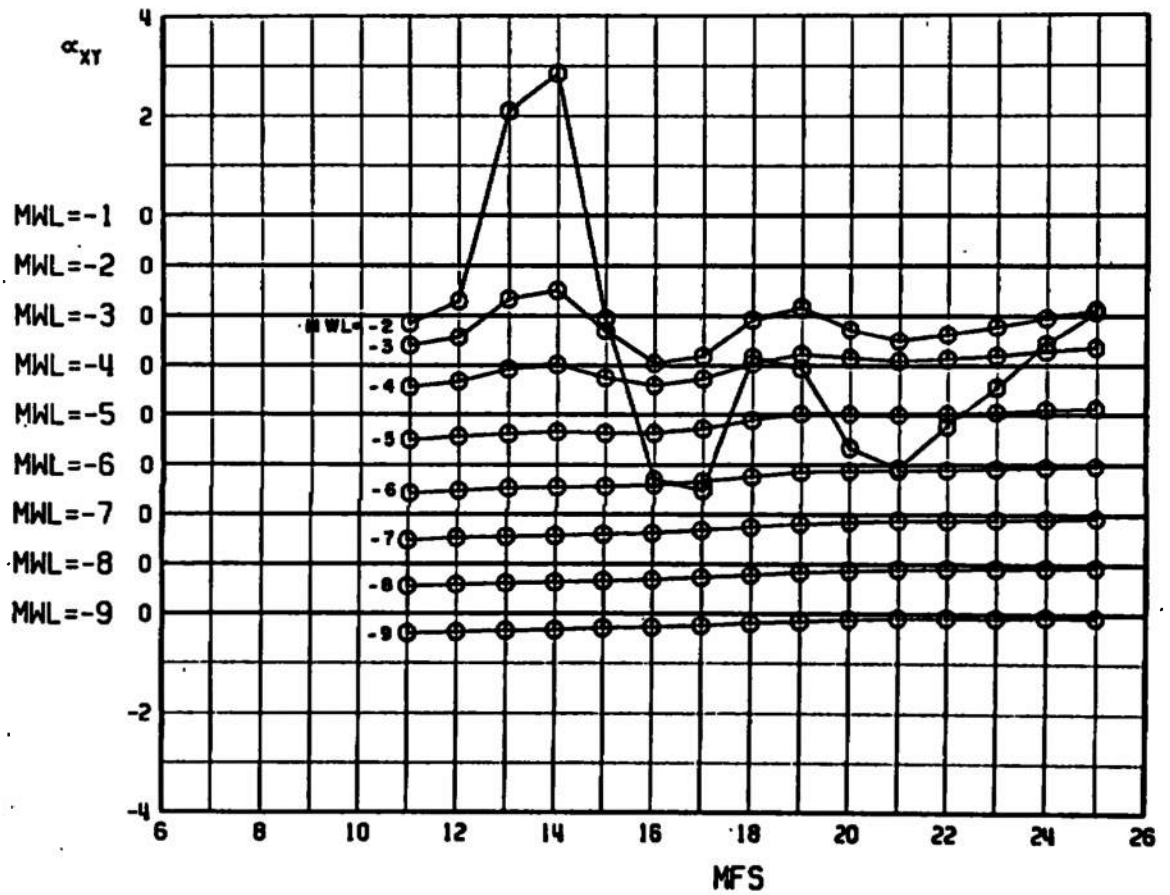


f. Sidewash, MBL 8
Fig. 22 Concluded

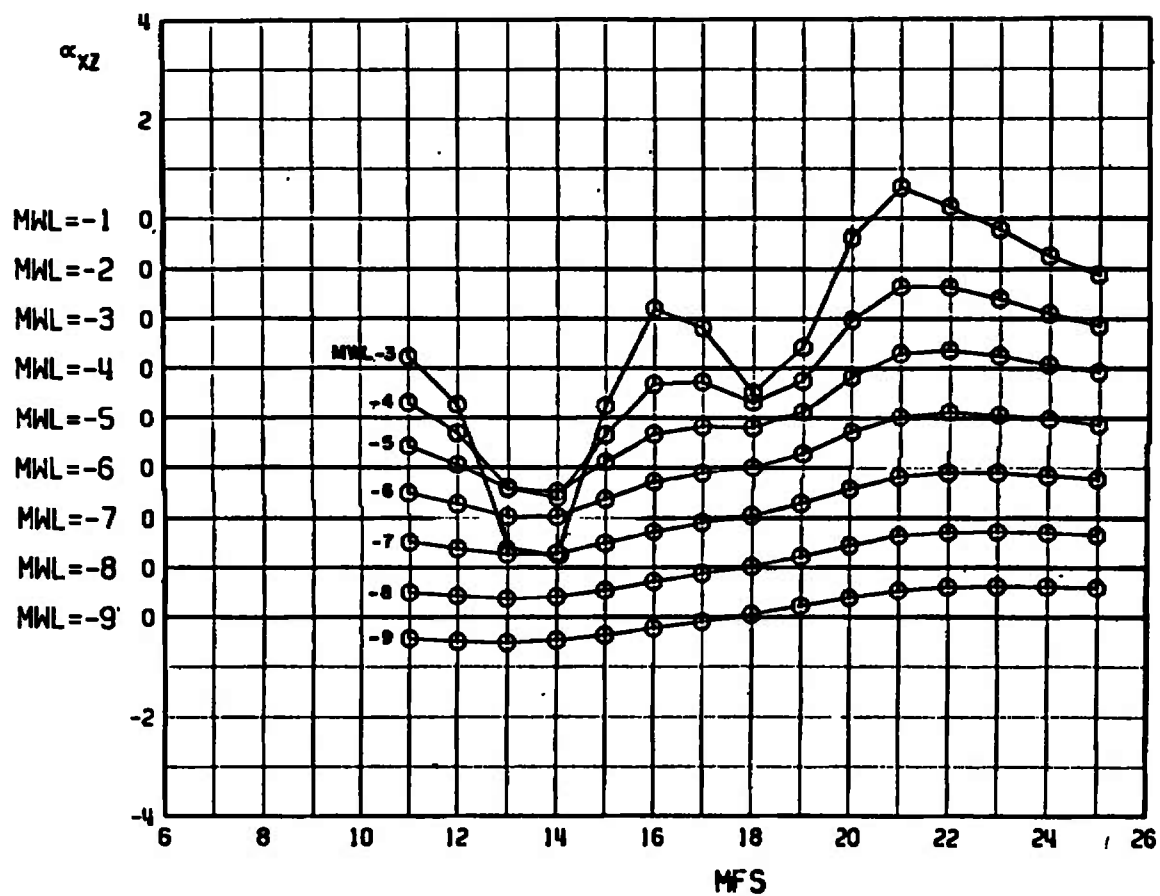


a. Upwash, MBL 6

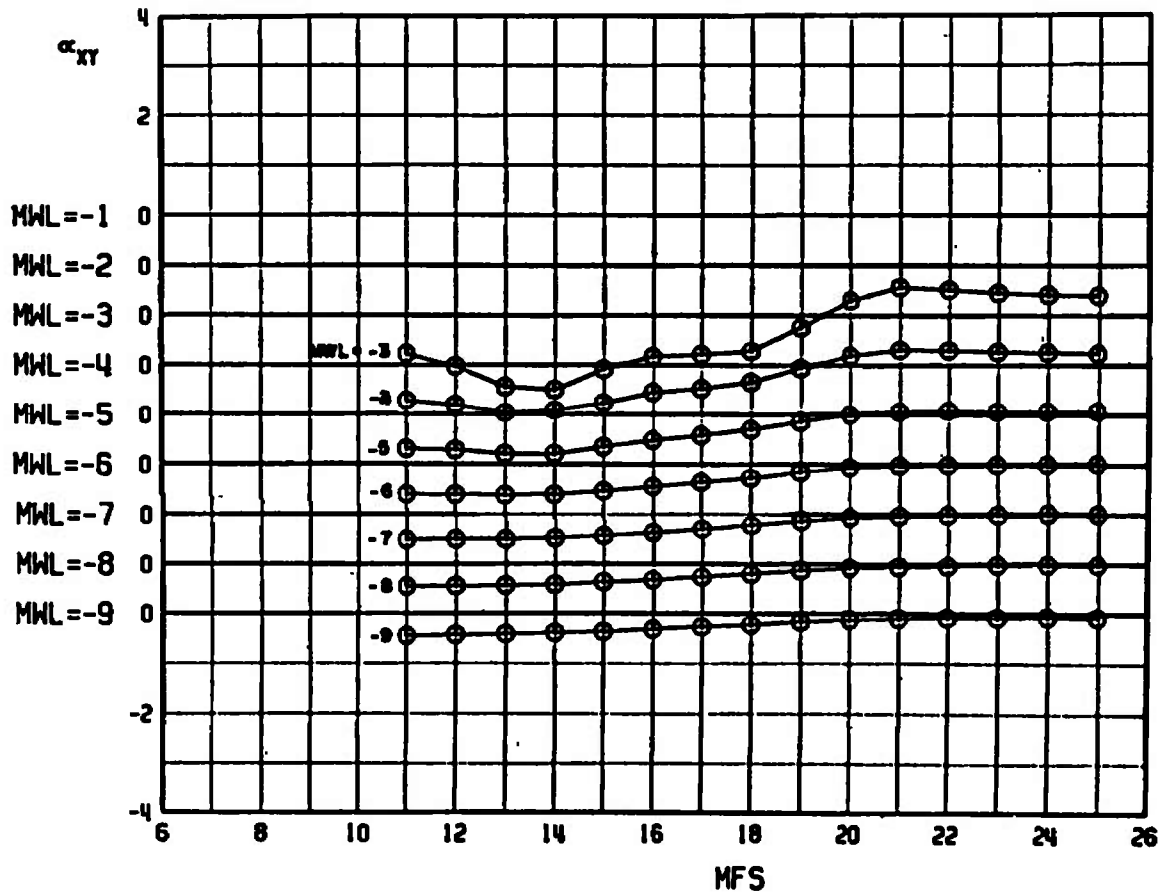
Fig. 23 Flow-Field Measurements beneath the Outboard Pylon, MER, and Six M-117 Stores at an Aircraft Angle of Attack of 0.30 deg, Configuration 10L



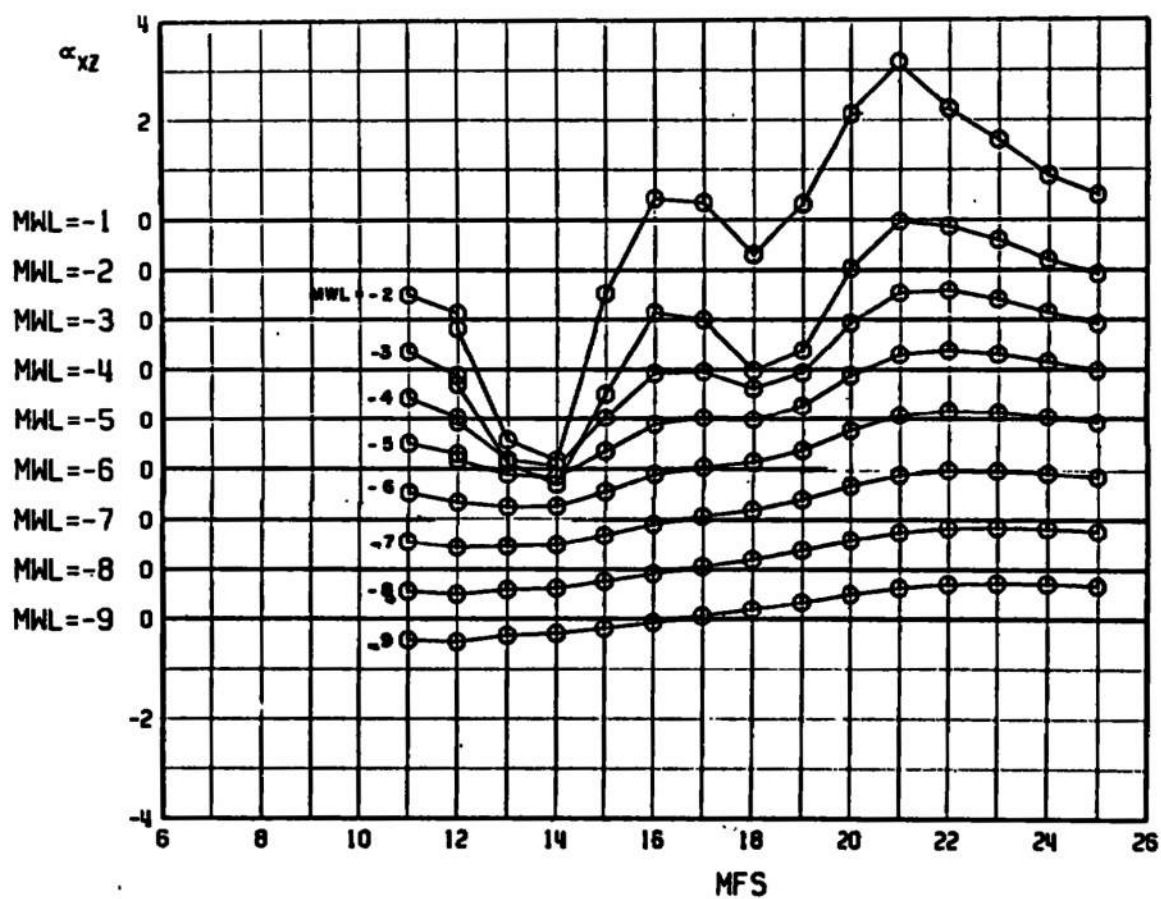
b. Sidewash, MBL 6
Fig. 23 Continued



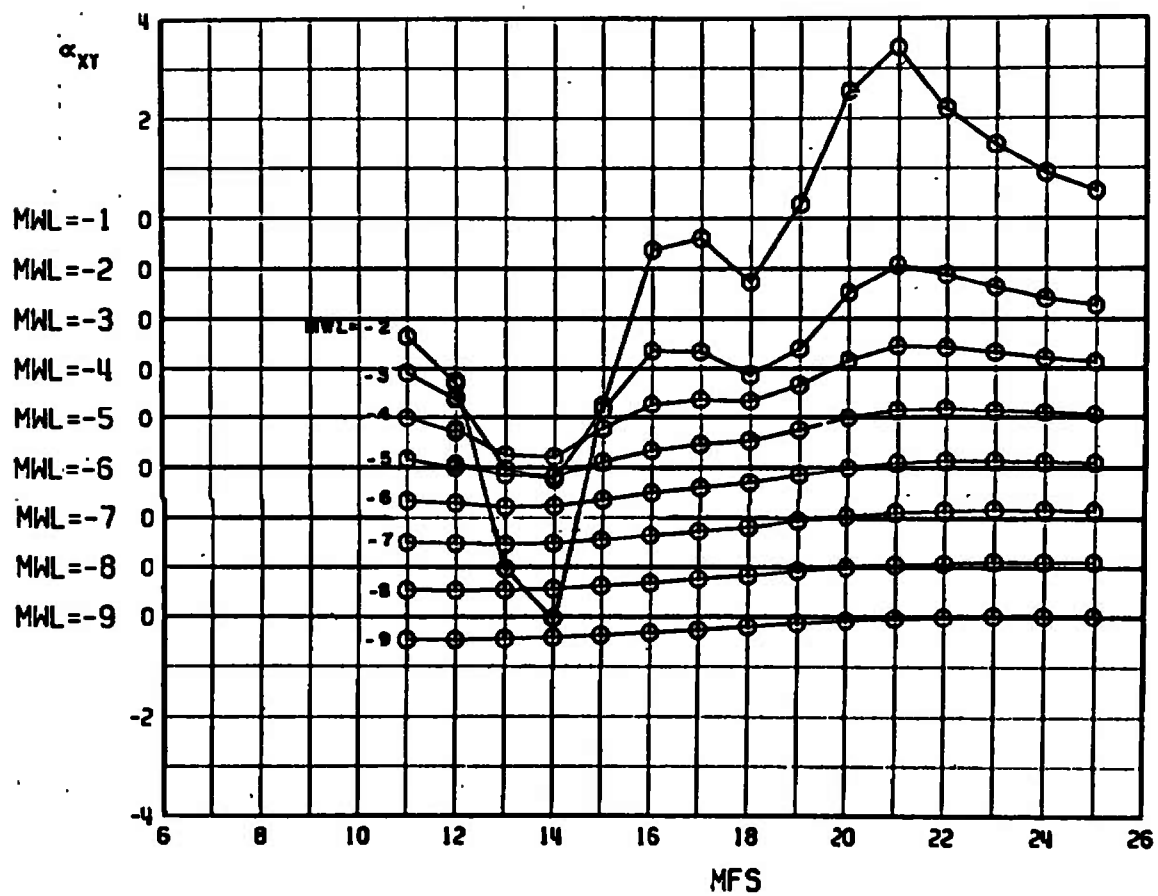
c. Upwash, MBL 7
Fig. 23 Continued



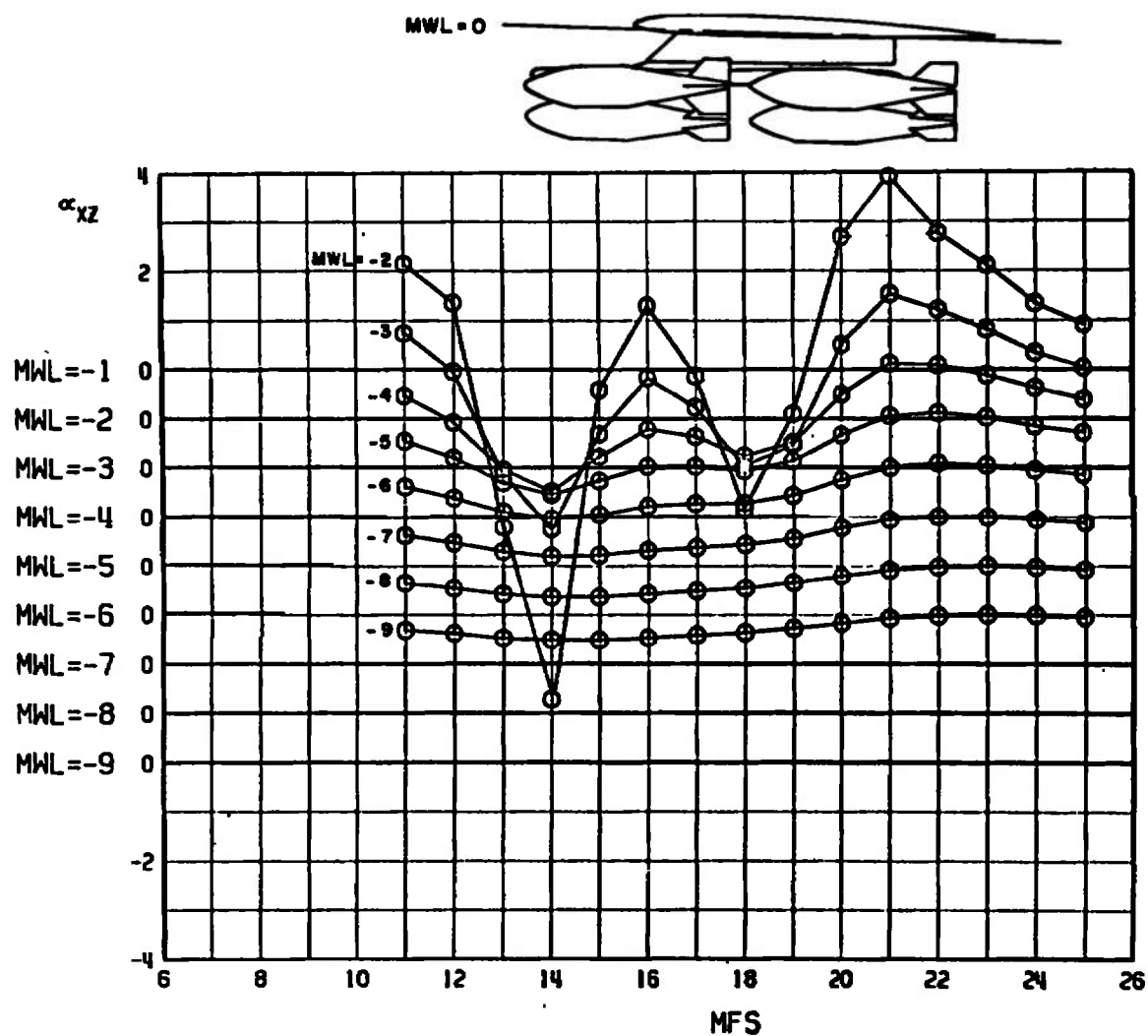
d. Sidewash, MBL 7
Fig. 23 Continued



e. Upwash, MBL 8
Fig. 23 Continued

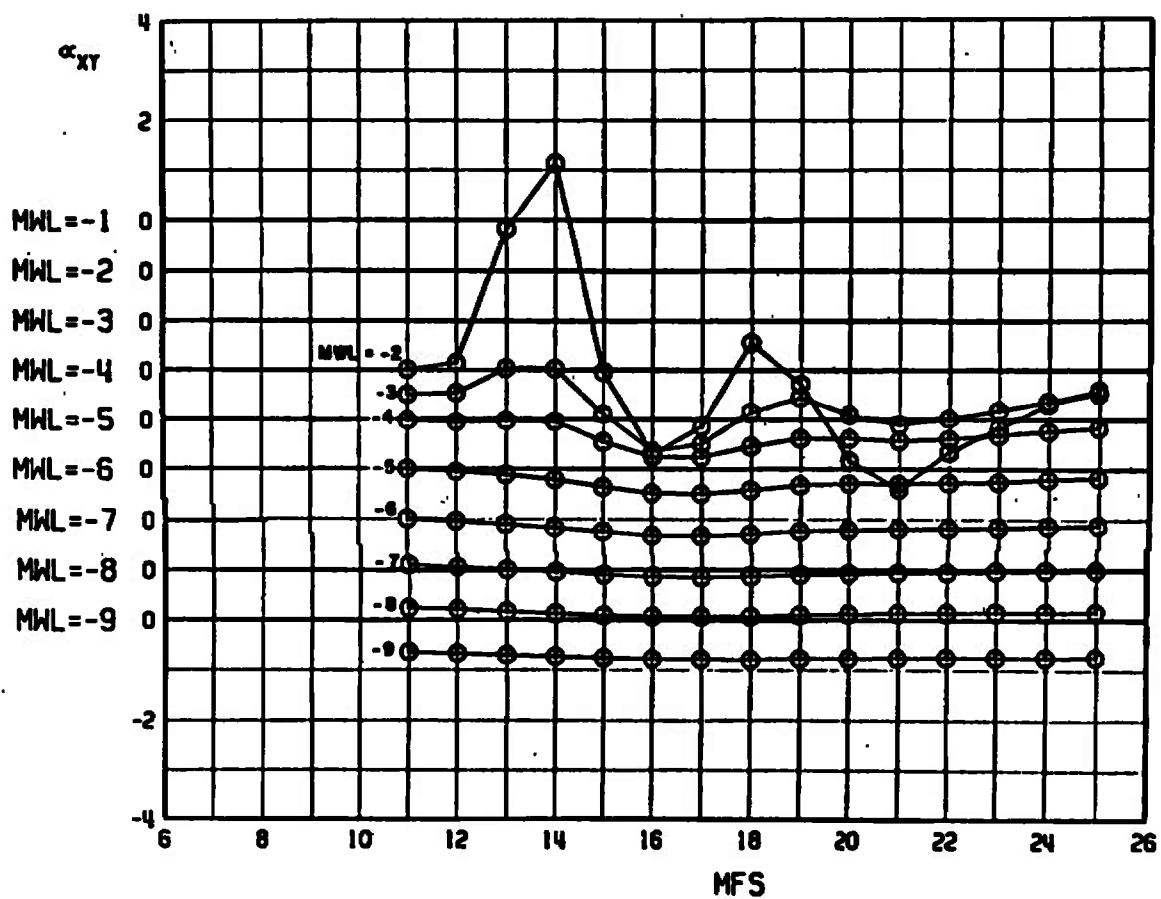


f. Sidewash, MBL 8
Fig. 23 Concluded

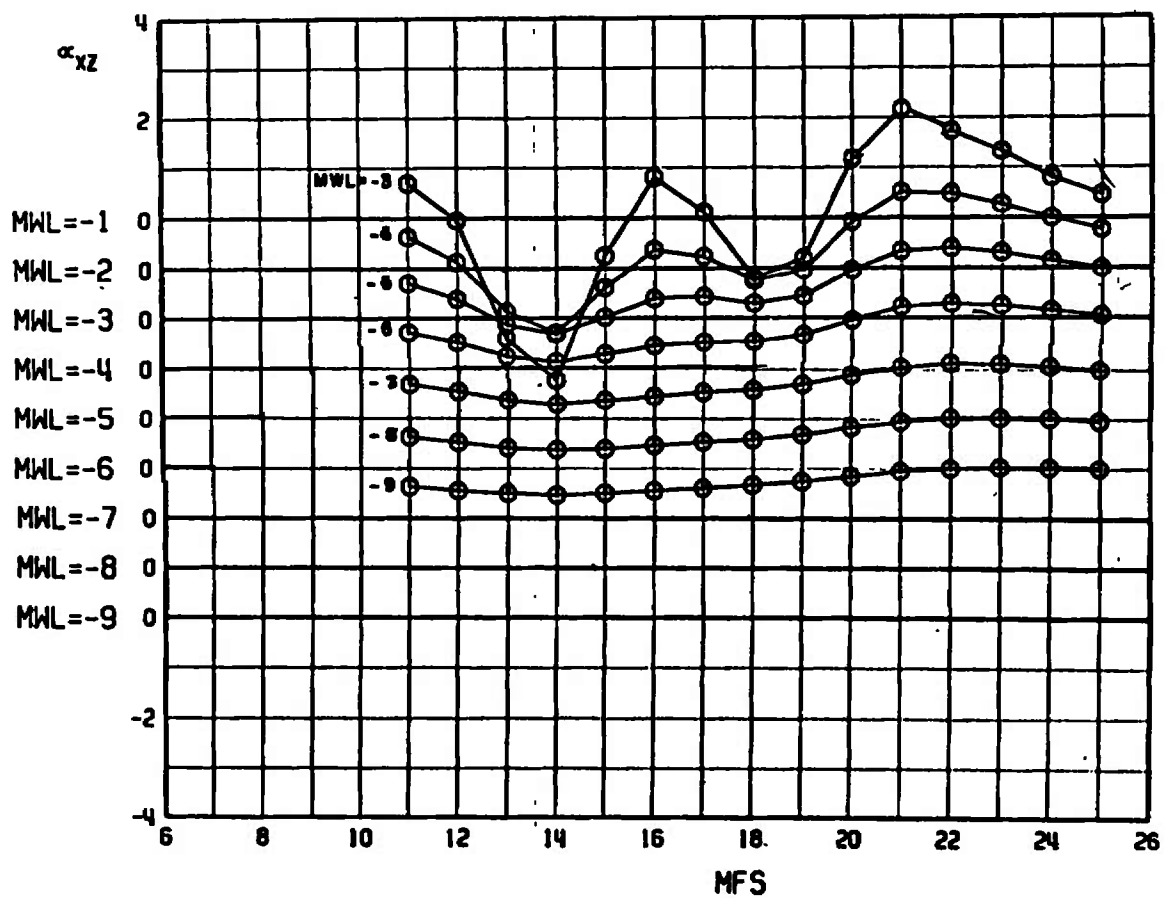


a. Upwash, MBL 6

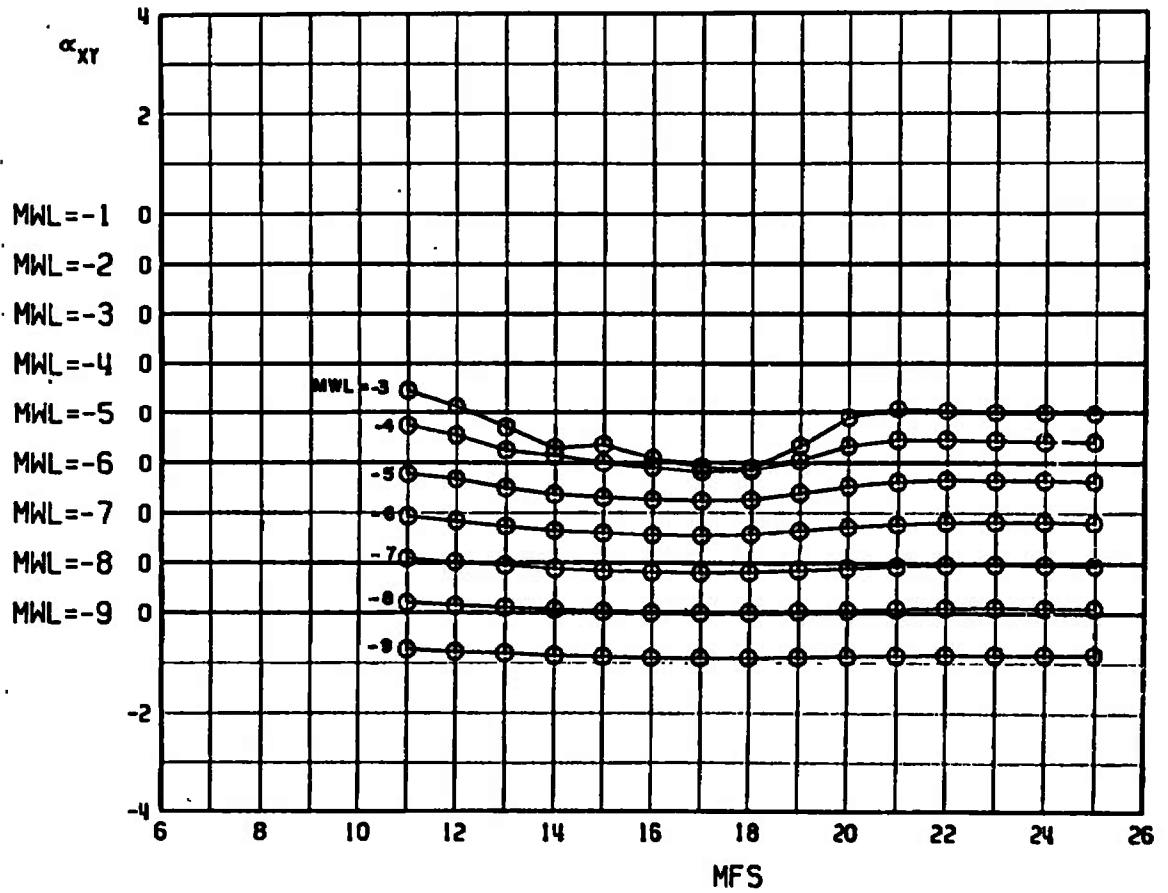
Fig. 24 Flow-Field Measurements beneath the Outboard Pylon, MER, and Six M-117 Stores at an Aircraft Angle of Attack of 3.30 deg, Configuration 10L



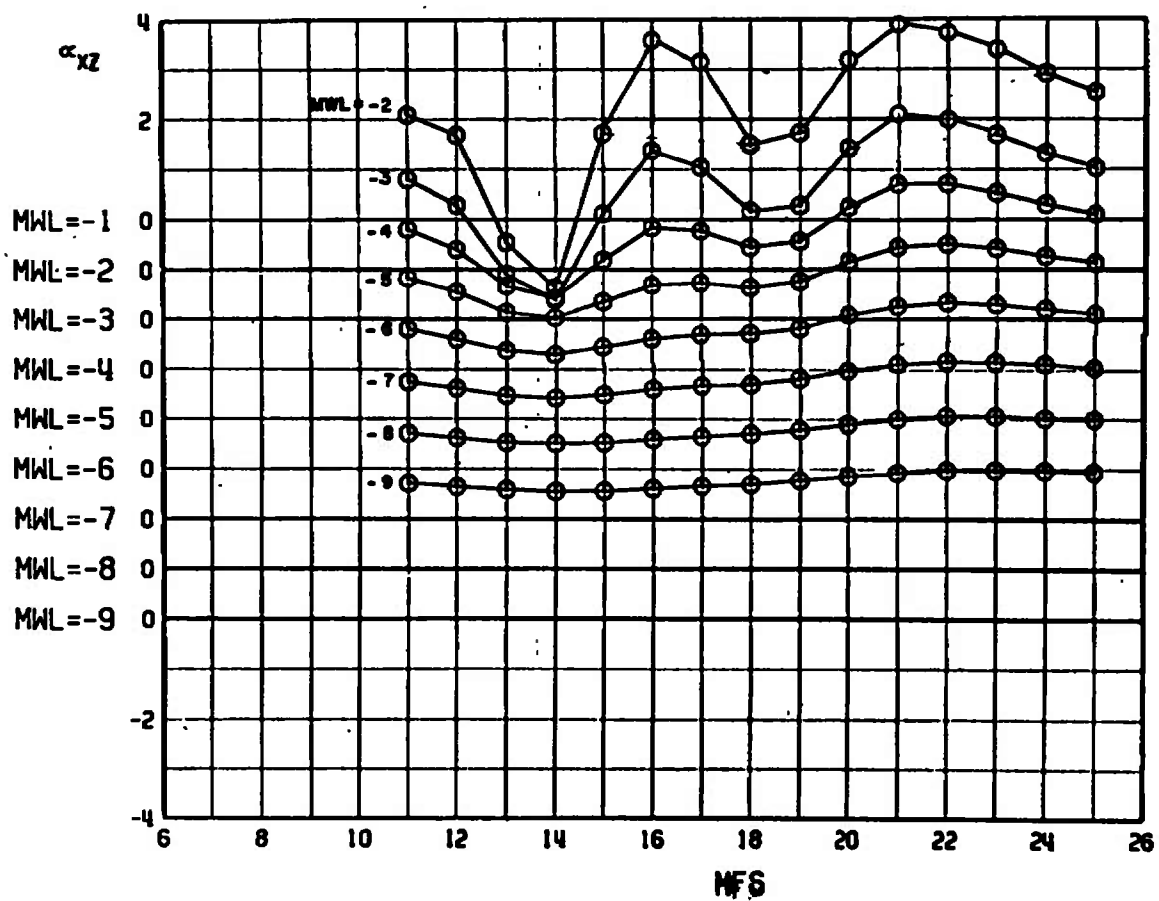
b. Sidewash, MBL 6
Fig. 24 Continued



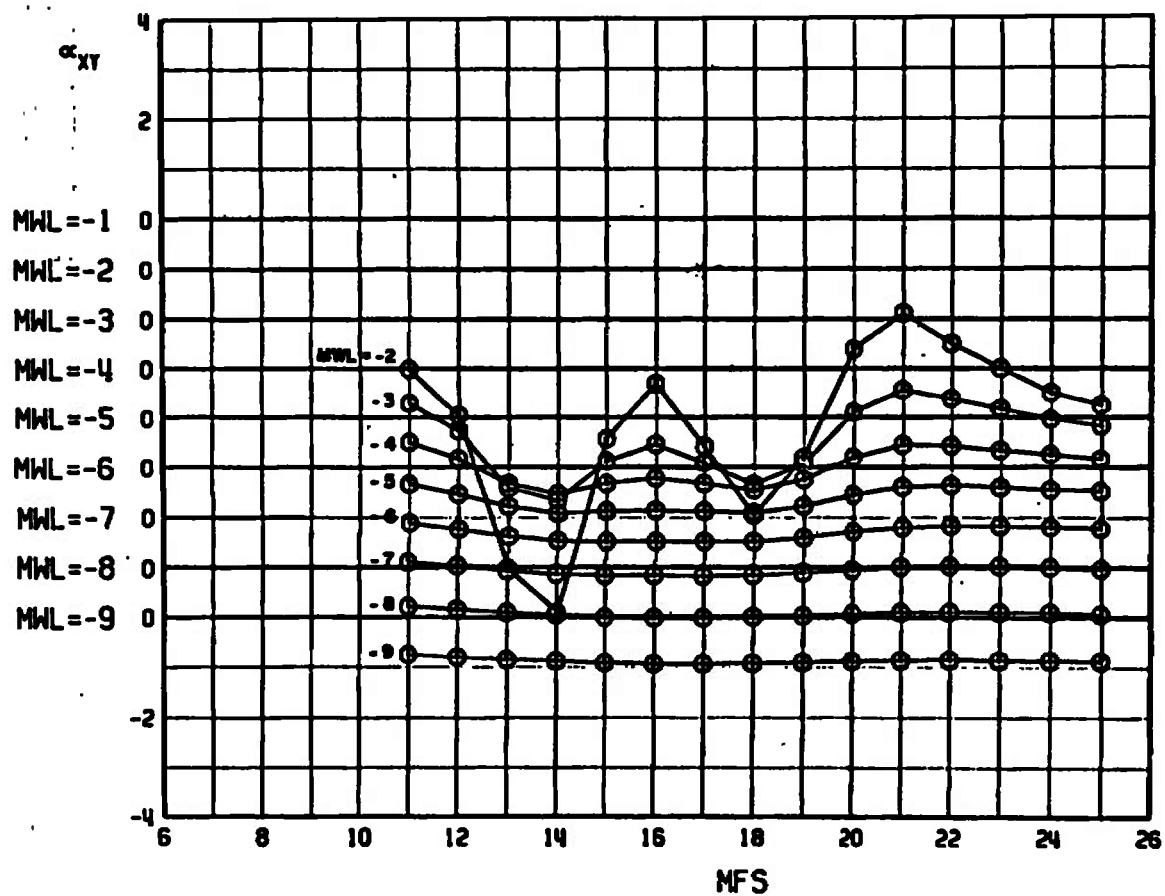
c. Upwash, MBL 7
Fig. 24 Continued



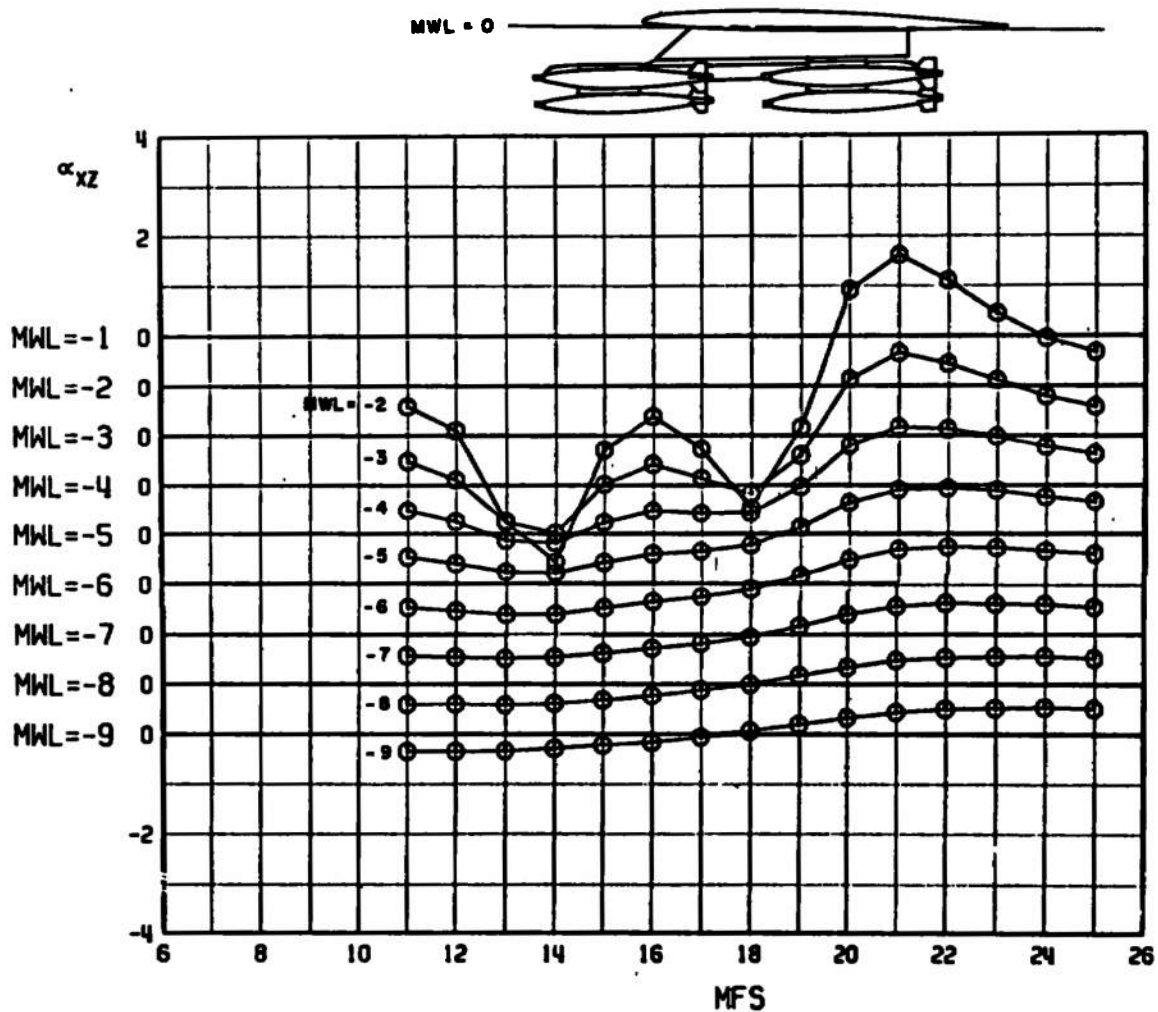
d. Sidewash, MBL 7
Fig. 24 Continued



e. Upwash, MBL 8
Fig. 24 Continued

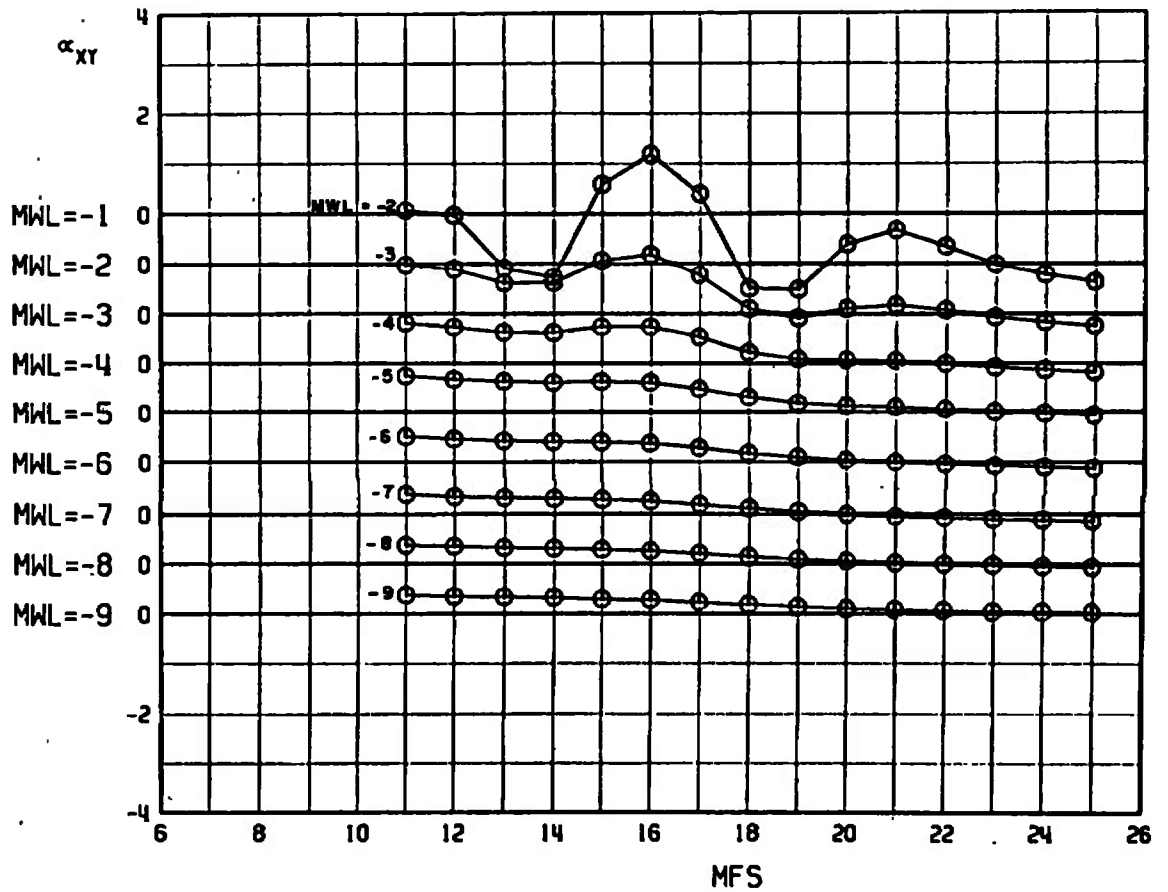


f. Sidewash, MBL 8
Fig. 24 Concluded

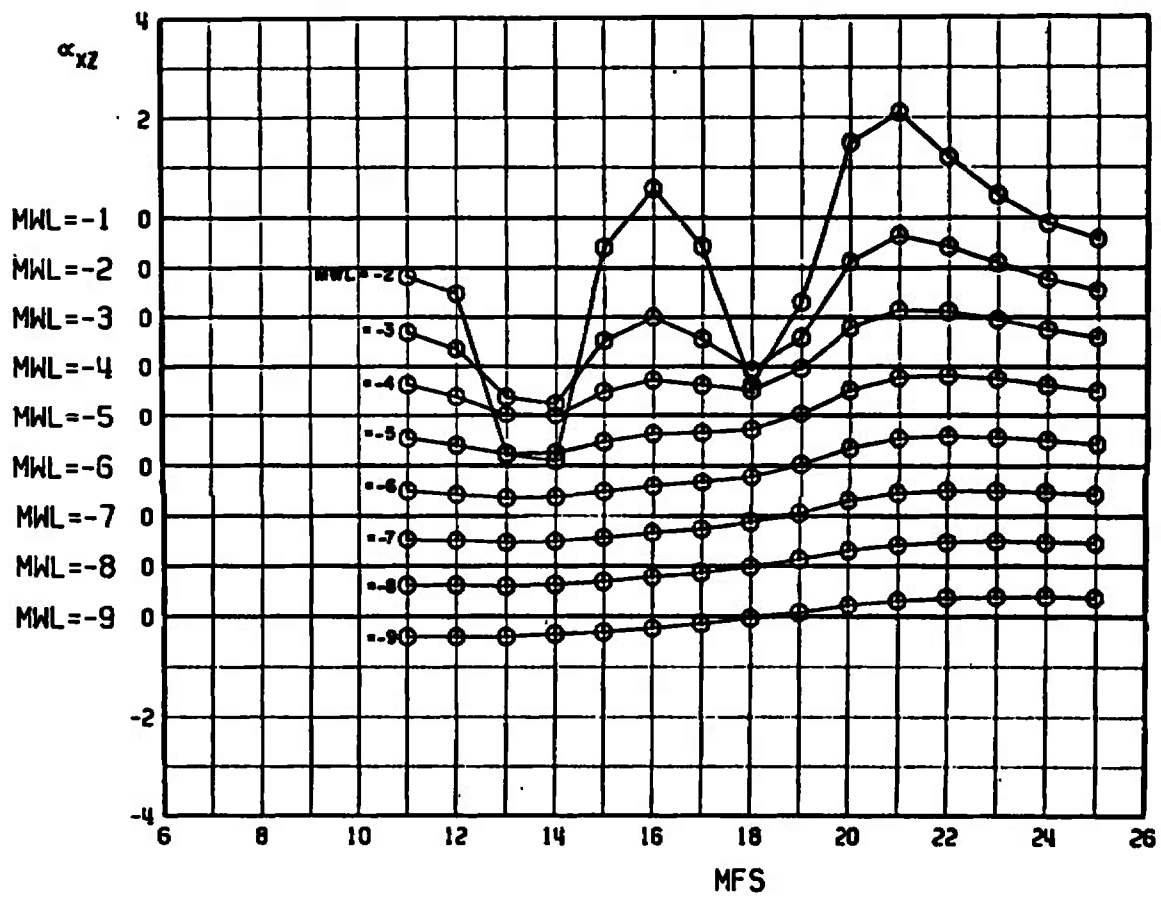


a. Upwash, MBL 6

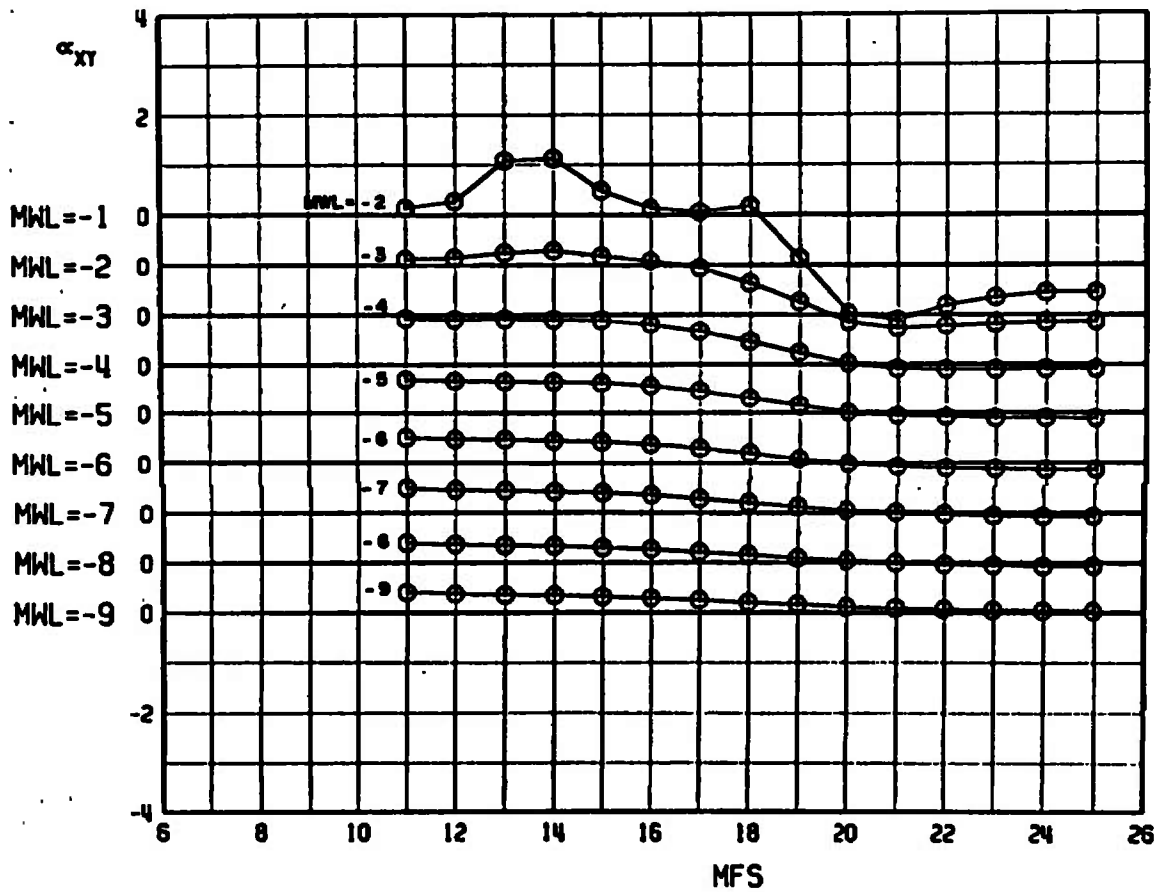
Fig. 25 Flow-Field Measurements beneath the Outboard Pylon, MER, and Six MK-81 Stores at an Aircraft Angle of Attack of 0.30 deg, Configuration 11R



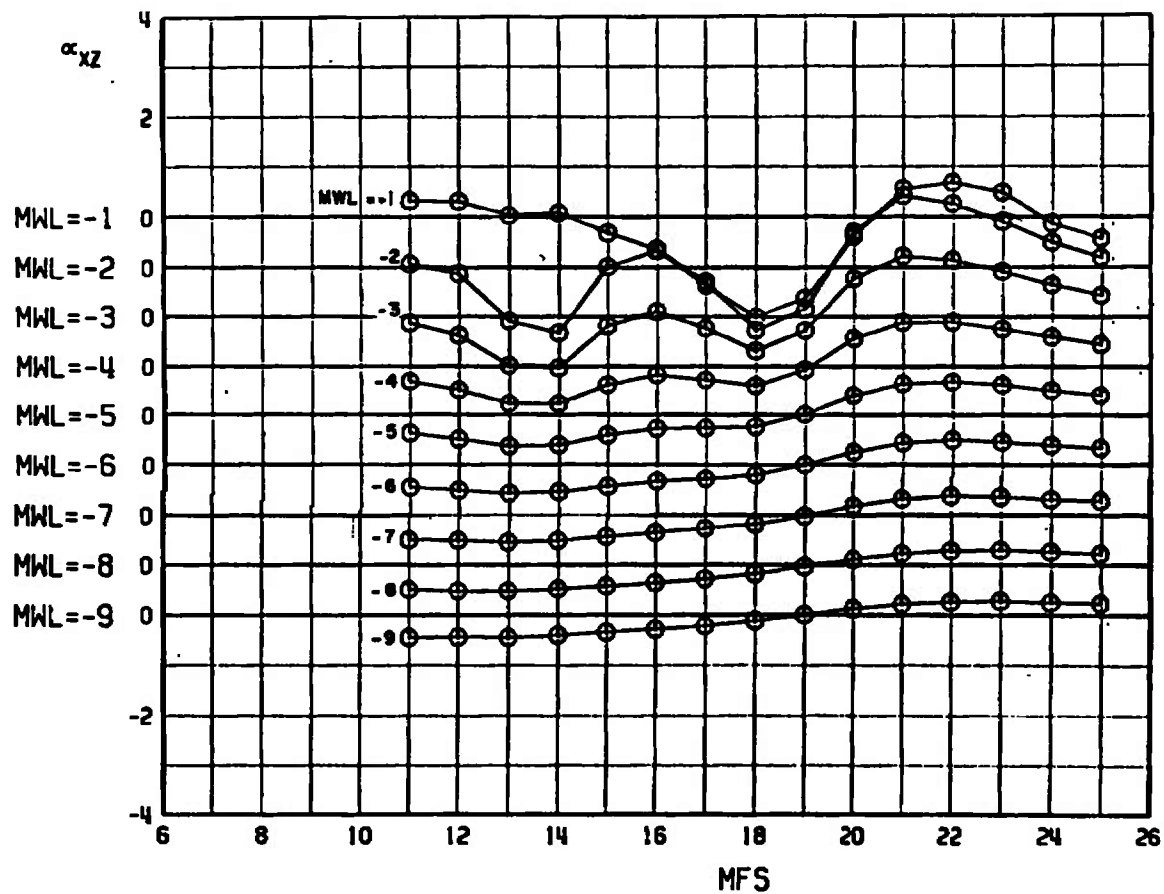
b. Sidewash, MBL 6
Fig. 25 Continued



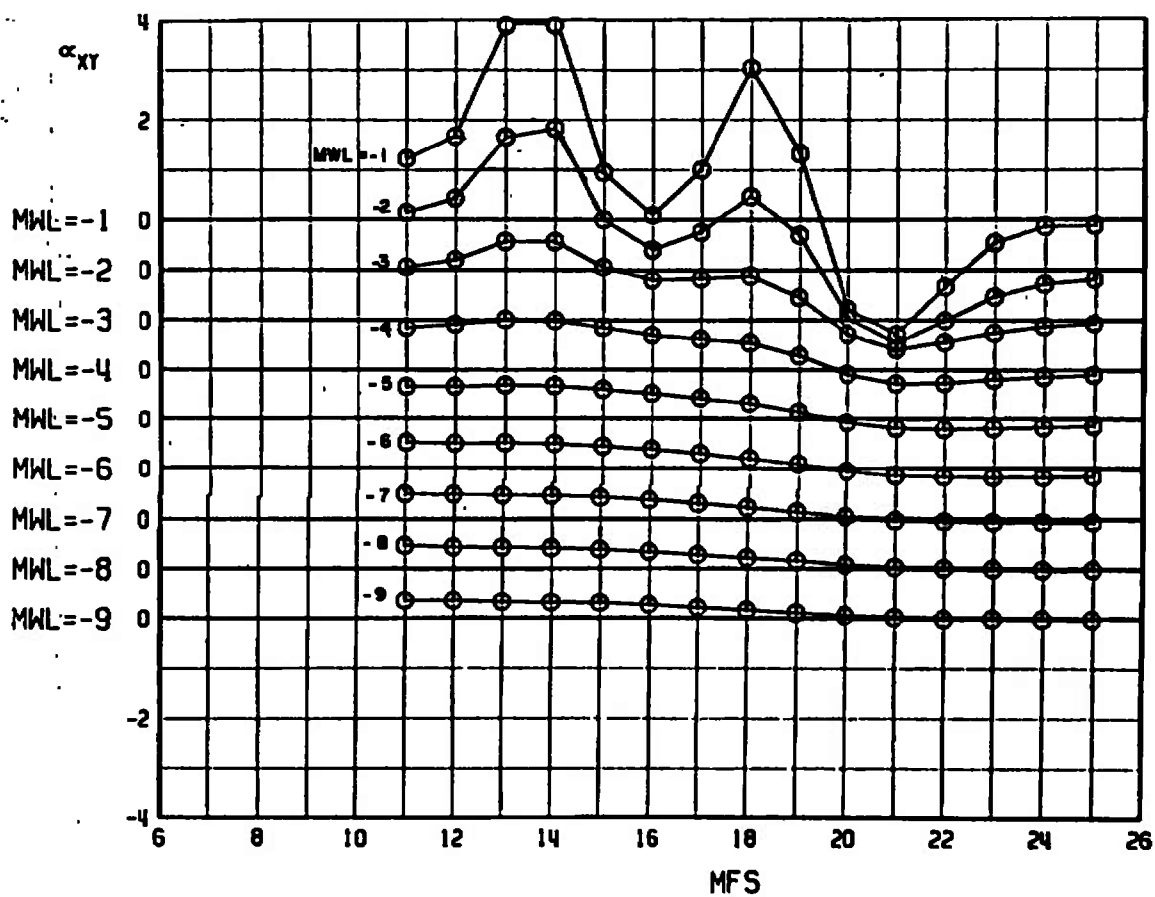
c. Upwash, MBL 7
Fig. 25 Continued



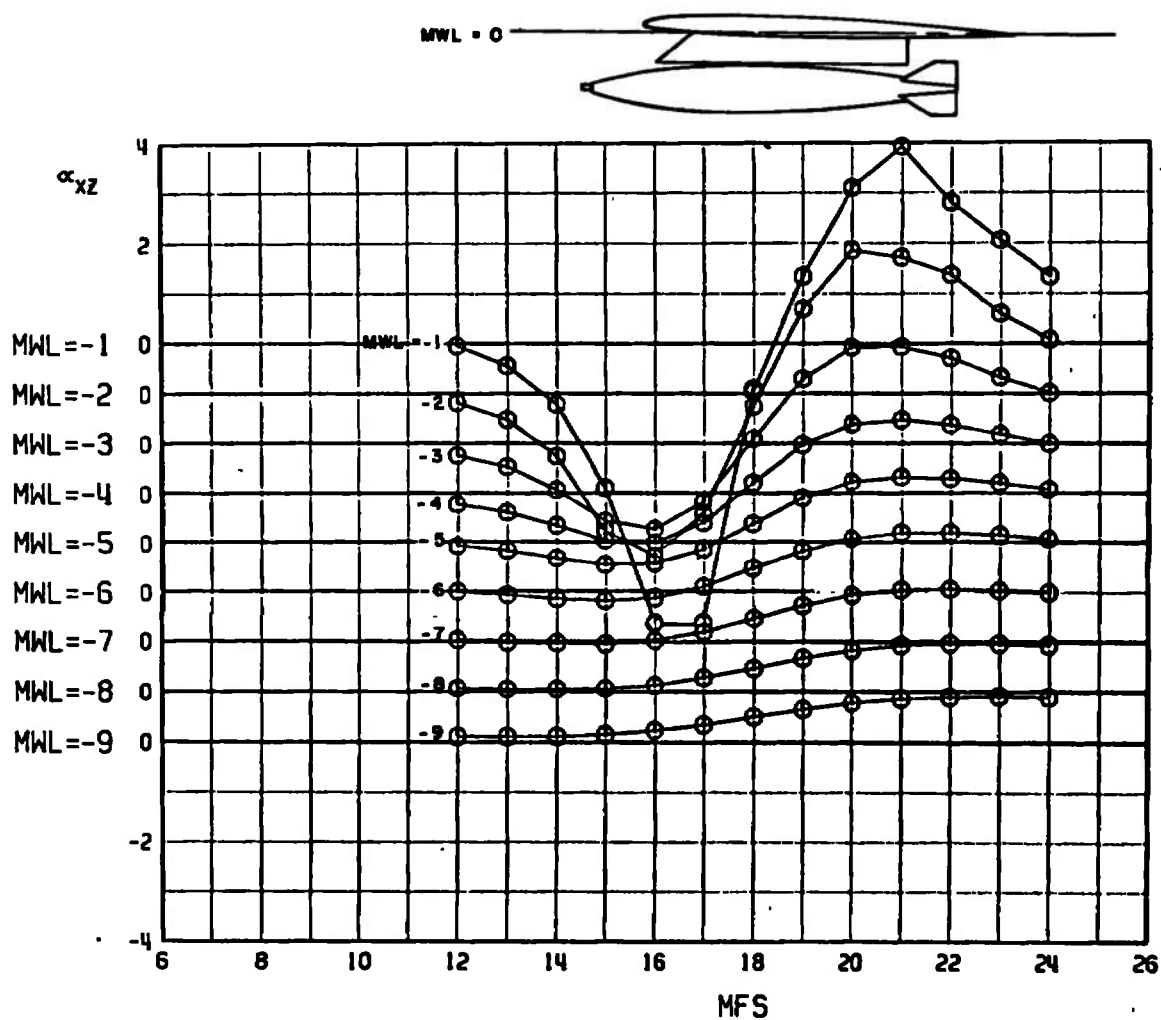
d. Sidewash, MBL 7
Fig. 25 Continued



e. Upwash, MBL 8
Fig. 25 Continued

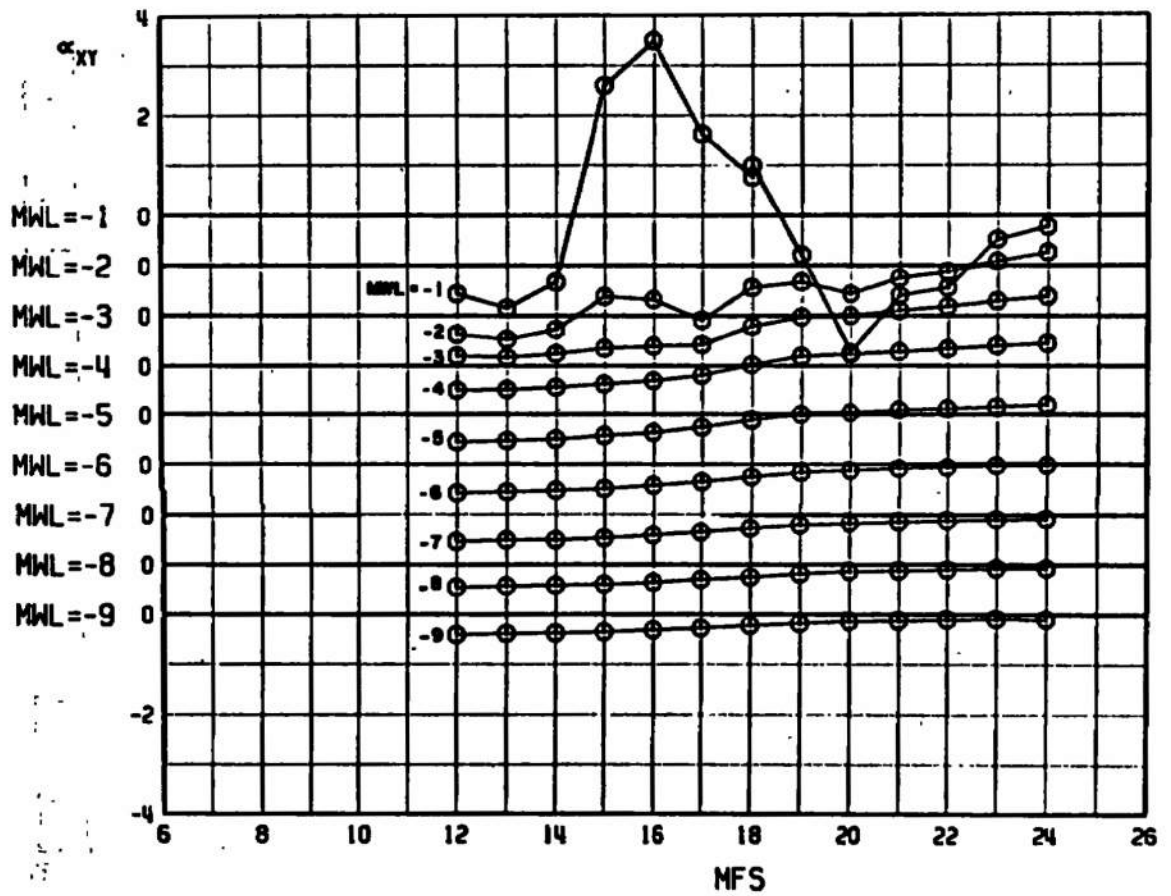


f. Sidewash, MBL 8
Fig. 25 Concluded

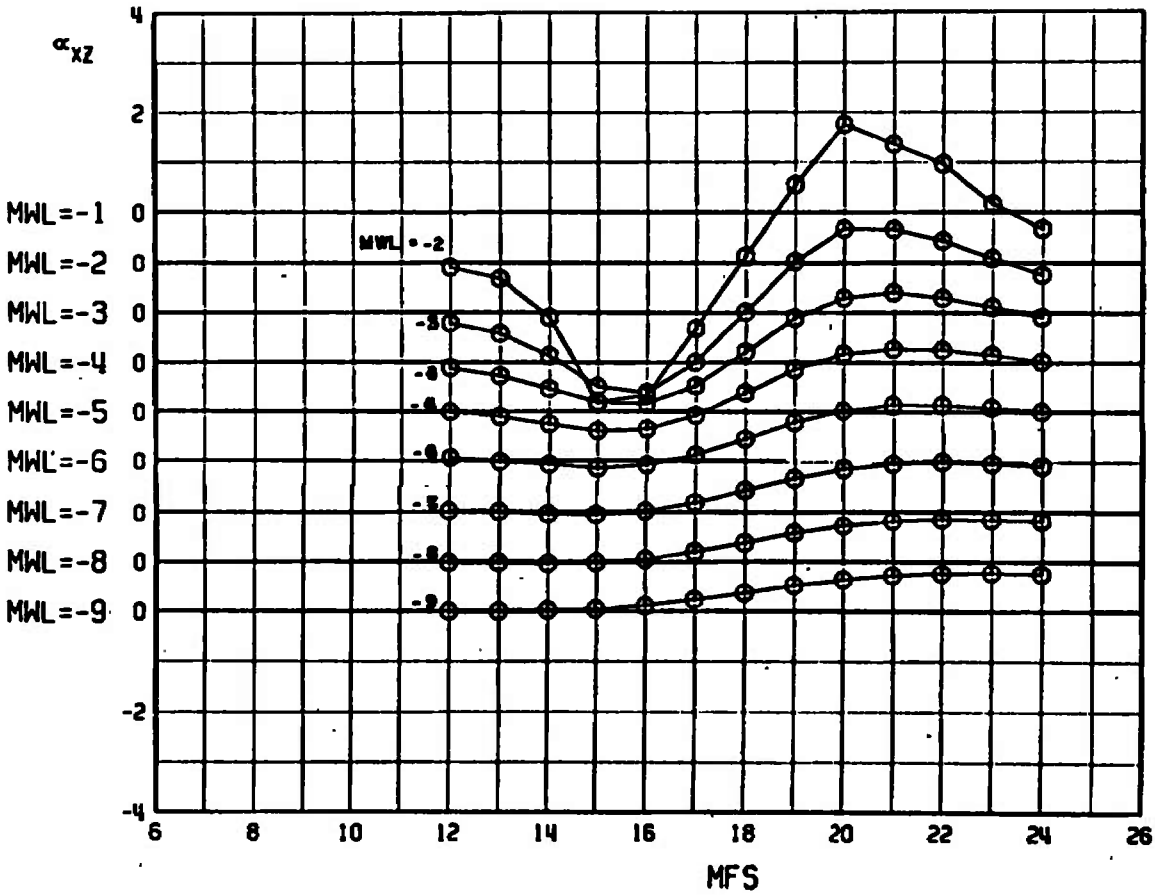


a. Upwash, MBL 6

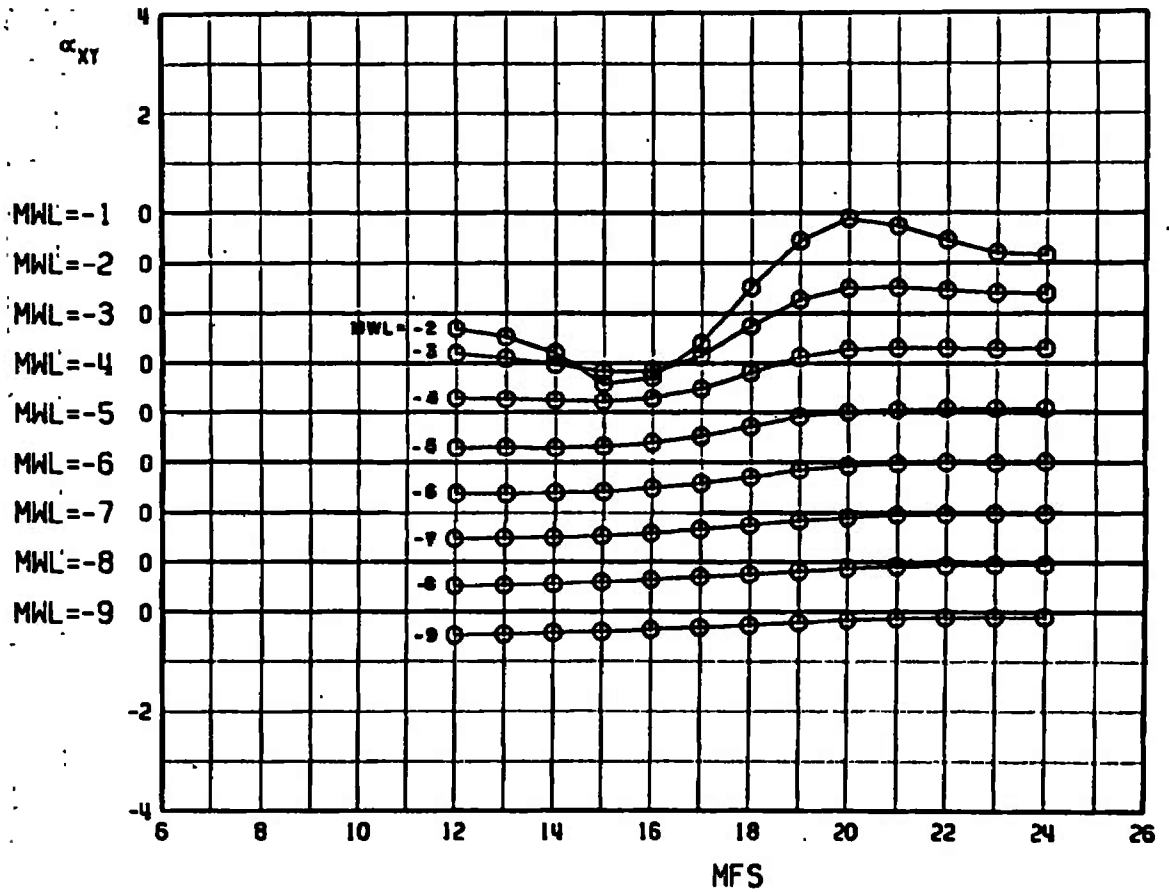
Fig. 26 Flow-Field Measurements beneath the Outboard Pylon and MK-84 Store at an Aircraft Angle of Attack of 0.30 deg, Configuration 12L



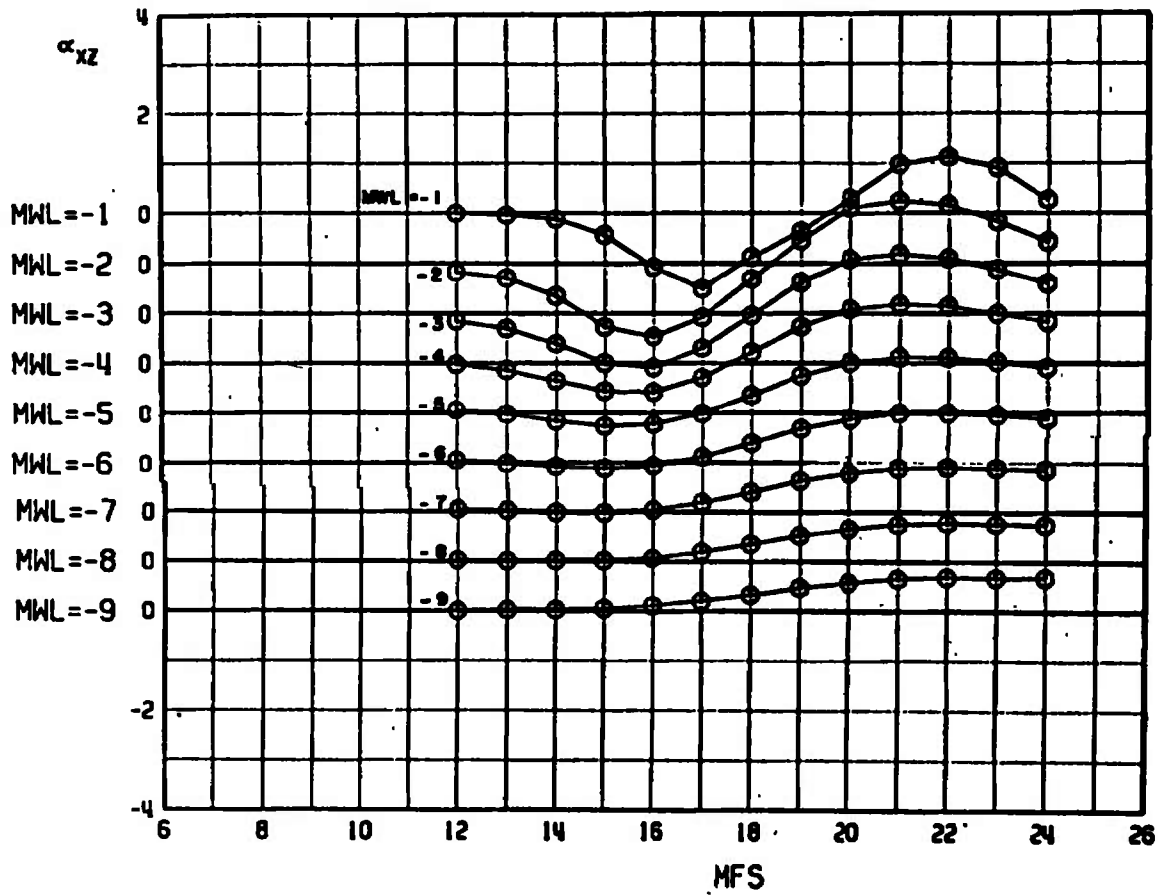
b. Sidewash, MBL 6
Fig. 26 Continued



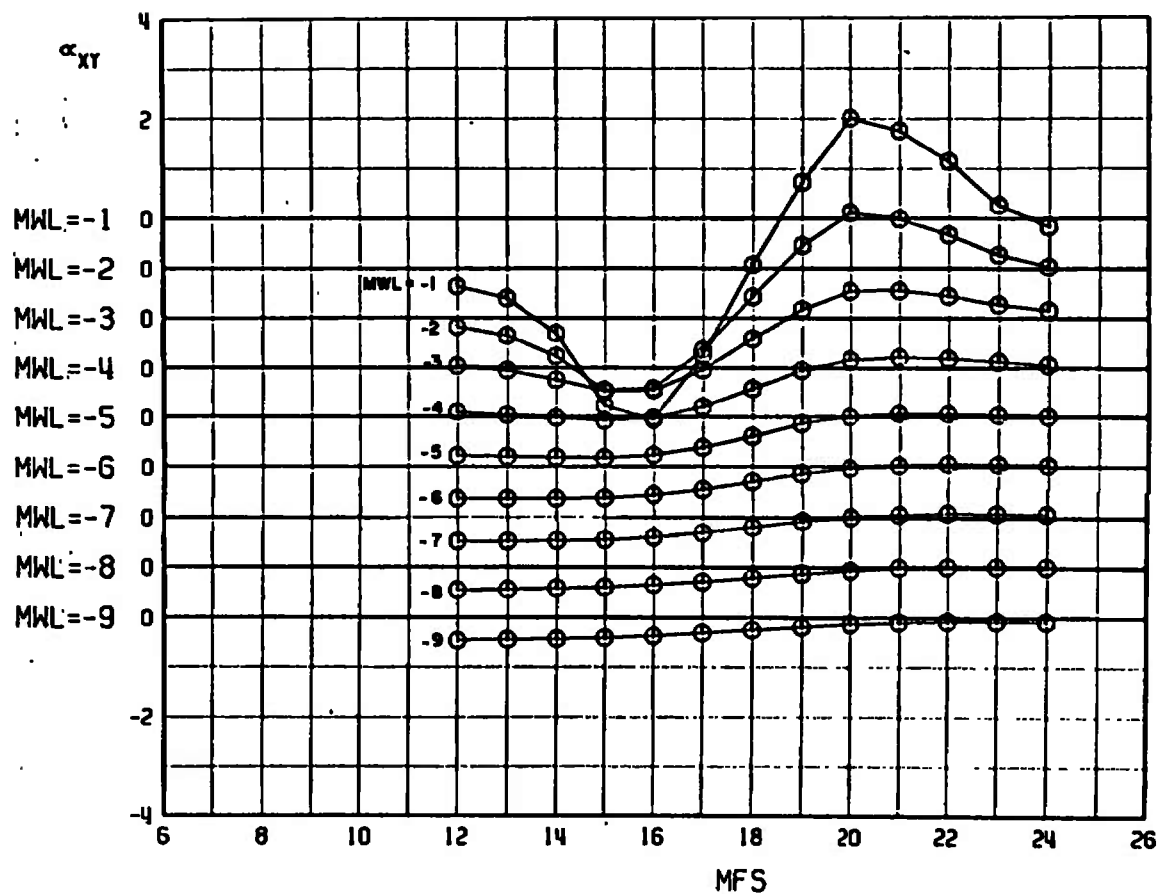
c. Upwash, MBL 7
Fig. 26 Continued



d. Sidewash, MBL 7
Fig. 26 Continued



e. Upwash, MBL 8
Fig. 26 Continued



f. Sidewash, MBL 8
Fig. 26 Concluded

**TABLE I
TEST SUMMARY**

Loading Configuration No.	Wing	Configuration	Region Surveyed				M_z	α
			Region	MFS	MBL	MWL		
1R	Right	Clean	Inboard	9 to 18	1 to 7	-1 to -9	0.85	0.30
2R	Right	Inboard Pylon	Inboard	13 to 22	1 to 7			
3R	Right	Inboard Pylon, TER	Inboard	9 to 18	1 to 7			
4L	Left	Inboard Pylon, TER: M-117 Sta. 1-3	Inboard	9 to 18	-1 to -7			
5L	Left	Inboard Pylon, TER: M-117 Sta. 2, 3	Inboard	9 to 18	-1 to -7			
6L	Left	Inboard Pylon, TER: M-117 Sta. 3	Inboard	9 to 18	-1 to -7			
7R	Right	Inboard Pylon, TER: MK-81 Sta. 1-3	Inboard	9 to 18	1 to 7			0.30, 3.30
8R	Right	Inboard Pylon, MK-84	Inboard	8 to 20	1 to 7		0.85, 1.30	0.30
9L	Left	Outboard Pylon and MER	Outboard	11 to 25	-3 to -9		0.85	0.30
10L	Left	Outboard Pylon, MER: M-117 Sta. 1-6	Outboard	11 to 25	-3 to -9			0.30, 3.30
11R	Right	Outboard Pylon, MER: MK-81 Sta. 1-6	Outboard	11 to 25	-3 to -9			0.30
12L	Left	Outboard Pylon, MK-84	Outboard	13 to 24	-3 to -9		0.85, 1.30	
13L	Left	Inboard Pylon, TER: MK-81 Sta. 2-3	Inboard	9 to 18	-1 to -7		0.85	
14L	Left	Inboard Pylon, TER: MK-81 Sta. 3	Inboard	9 to 18	-1 to -7			
15L	Left	Outboard Pylon, MER: M-117 Sta. 2-6	Outboard	11 to 25	-3 to -9			
16L	Left	Outboard Pylon, MER: M-117 Sta. 3-6	Outboard	11 to 25	-3 to -9			
17R	Right	Outboard Pylon, MER: M-117 Sta. 4-6	Outboard	11 to 25	3 to 9			
18R	Right	Outboard Pylon, MER: M-117 Sta. 5-6	Outboard	11 to 25	3 to 9			
19R	Right	Outboard Pylon, MER: M-117 Sta. 6	Outboard	11 to 25	3 to 9			
20R	Right	Outboard Pylon, MER: MK-81 Sta. 4-6	Outboard	12 to 24	3 to 9			

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13. ABSTRACT

Tests were conducted to measure the velocity vector components in the flow field beneath the wing of the F-4C aircraft at Mach number 0.85. A conical-tip pressure probe was used to measure the velocity vectors beneath the wing with configuration combinations of pylons, Triple Ejection Rack (TER), Multiple Ejection Rack (MER), M-117, MK-81, and MK-84 stores. Results of the test indicate that the severity of the upwash and sidewash flow increased with the addition of pylons, TER, MER, and stores. The M-117 stores on the TER and MER produced the most severe flow field distortions. Also, the longitudinal gradients of upwash and sidewash flow decreased with an increase in aircraft angle of attack.

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of military hardware; June 1972; other requests for this
document must be referred to Air Force Armament Laboratory
(DLGC), Eglin AFB, FL 32542.

14.

KEY WORDS

LINK A

LINK B

LINK C

ROLE

WT

ROLE

WT

ROLE

WT

investigation

flow

fields

external stores

F-4C aircraft

Mach number

velocity